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Architecture Master's Dissertation
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Workshop Theme: Urban Design

Integrated process for Oasian ecosystem preservation.
Case study : Bousaada

G.P : Scientific Research of Natural Resources, Learning and Leisure Center.

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Dedication:

I dedicate my thanks to my immediate context first and foremost, my family, to my mother and father, to my siblings.

I thank Mr.Dahmani, my mentor for the unexpected journey that this year has been and the opportunities he has offered and the lessons he's taught me.

I would also like to thank my close and far away friends, and the people of bousaada who have been so kind hearted to assist us in every step of the way.

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I express my thanks to anyone who has participated in the formulation of the work, whether close or far away, to all my friends, and the people of Bousaada, from the common folks to the experts we have consulted.

Lastly I wish to thank my supportive family, my mother and father, siblings, and my friends.

ABSTRACT:

Our case study will be BOUSAADA, it's oasis is an undeniable resource; its strategic location at the Sahara's entrance, encompassing both plains and desert climate gives it its character and makes it irreplaceable, the properties it gathers from its location makes for a unique and vital local ecosystem, in our context, such scarcity must be protected and maintained at all costs.

Laws and government regulations have always been stringent on preventing crimes, injustice and corruption in society, but there doesn't seem to be any concern, reflected in law that ensures that man does not harm his own environment (and that especially in our country of Algeria), this being a matter of a whole species survival, it is where this project's intervention becomes vital in identifying and laying out such information, so that it's importance becomes more visible.

In our immediate context, the destruction or misuse of local natural resources can be very damaging in the long term, as everything happening within it is part of a one continuous cycle encompassing a multitude of processes that we are indeed a part of, and so in disrupting the equilibrium of a local ecosystem by forcing ourselves upon it in ways that harm the natural processes that occur, we endanger our own permanence in it.

A simple yet vital example for this can be water, by polluting surface water through household waste, we participate in polluting what will eventually be a clean water supply, since surface water that takes the form of lakes, ponds or creeks eventually lead to aquifer recharge areas, which in turn lead to the aquifers, and thus by polluting surface water we have successfully polluted one of the most important sources of clean fresh water that we can use, represented in aquifers, and that is just one example.

By contrast, this can be a good indicator for a project's permanence within the space of the oasis, since we can judge objectively how ''good'', or ''effective'' our interventions are by directly studying the degree to which these interventions are positively integrated into local processes, if they do not disturb the ecosystem's work, or better yet, if they manage to integrate it and be part of it, let alone enhance it, the work of this thesis will have been a success to a certain extent.

As mentioned previously, the objective is to propose not only an intervention that ensures the conservation of the oasis space by making the most intolerant parts of it off-limits, but also by projecting interventions on the area itself, for projects that can potentially increase its attractiveness and thus help it receive more attention from localities and responsibilize them when it comes to preserving it, and in that way introduce those same people to the ecosystem.

When we talk about conservation in this context, it is not just implied that the operation is about preserving a part of the city itself, but in broader terms, the work proposed is that of a new methodology (new in our country) for studying, overlaying and estimating value of land for future interventions, the method consists of ranking the importance of ALL FORMS of local natural resources, from most to least vital in terms of preservation, (these include natural resources that represent SOCIAL values), and thus allowing for projection that avoids the use of IRREPLACABLE land of vital importance, ensuring their added value to the city AND their protection.

Keywords: oasis, ecosystem, social values, environment.

Chapterisation:

The entirety of the thesis will span three main chapters, alongside a fourth conclusion chapter:

Chapter 1: Introduction

The first chapter contains the introductory part; it will serve as a base for the thesis by presenting the theme and main problematic, as well as some hypotheses along the way.

Chapter 2: Theoretical part

The second chapter will constitute the research part of the topic, the literature and various definitions encompassing the theme, including a solid literary base for the choice of methodology.

Chapter 3: Case study

The third chapter follows directly the research part as both a theoretical and practical exercise and application of all the principles that have previously been built upon, the goal being to respond to the aforementioned problematic through a rigorous process of adapting concepts and methodology on a case study.

Conclusion:

Consists of a recapitulation of the study, comparisons and results of research and assessment of hypothesis.

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CHAPTER 1:
Introduction

I. INTRODUCTION:

The importance of understanding our context beyond the notion of a set of static elements has proven to be vital to us over the years, through time, man's relationship with his surroundings has been complex, at times man would be seen living in complete harmony with nature even though he did not understand how all of its elements came together, but over time he started taking over, slowly entering the era of the Anthropocene and potentially accelerating what will be his own extinction.[1]

The ever-present problematic that now arises with the entrance of man into the scene and him taking over nature and inserting himself as dominant species is akin to signing his own eventual demise, man seeks control over the natural world, without understanding that he is situated within preexisting system that goes beyond anything he has known yet, and thus, destroys the very environment that is sustaining him.

It is VITAL for man's survival that he understands the world around him, it's elements, and the impossibly **complex relationships**[2], processes and values that these entertain, man cannot simply walk into this immense machine comprised of all forms of living and non-living organisms, of atoms and molecules that go through these closed loops, forming and reforming themselves, simply taking from the system means potentially meddling with its balance, he has to understand how interactions work to better live with the system and integrate himself.

Man's integration to **natural systems**[3] and **processes**[4] around him isn't just an effort to conserve what exists and do as little harm to it as possible, it's also a way for him to facilitate a lot of his own processes, why create alternatives when the most efficient models of self-sustaining systems are already existing and right next to us, we

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[1] Elizabeth Kolbert, (2014), The Sixth Extinction: An Unnatural History.New York : Henry Holt and Company.

[2] Edward O. Wilson (1992). The Diversity of Life. Belknap Press, United States : Cambridge.

[3] C. A. Brebbia, (2013), Eco-architecture IV: Harmonisation between Architecture and Nature, UK: Southtampon.

[4] Fritjof Capra (1996). The Web of Life: A New Scientific Understanding of Living Systems. New York : Anchor.

can allocate a lot of our own needs to those ecosystems and by participating, we ourselves can contribute to the loop, not as destroyers or simply takers, but as genuine contributors, present to enhance and protect a system that could sustain us in many ways.

Now that we have understood that the natural world works according to processes, we can now start considering integrating it into our planning practices, with the aim to preserve it, not only for its **intrinsic value**[5] but also because of the value that it adds to man, the matter now is to create new public values, and then to incorporate resource values, social values and aesthetic values as well as others, alongside the normal criteria like engineering considerations, physiographic criteria and others, all with the goal of incurring the **least social cost**[6], for the most social benefit.

II. GENERAL PROBLEMATIC:

The natural world[7] is a major factor in human survival, and sustainability goals have to be achieved. Humans and nature have always shared the same context, from ages past until the most recent periods of time. The people living in Algeria have been shown to have an incredible range of adaptive behavior all throughout the territory, once again the very unique nature of the country's geographical situation allows it to welcome many types of environments and climate conditions, most notably the coasts at the north, the highlands as we move down to the middle, and lastly the Saharan desert to the south, to each of these environments we have remarkable examples of **adaptive strategies**[8], that manifest themselves in the built, the social, and the cultural environments among others.

[5] Ian L. McHarg , (2006),The Essential Ian McHarg: Writings on Design and Nature, Washington DC: Island Press. P 47

[6] Ian L. McHarg , (2006),The Essential Ian McHarg: Writings on Design and Nature, Washington DC: Island Press. , P145

[7] Robin Wall Kimmerer (2013). Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge, and the Teachings of Plants., Minneapolis : Milkweed Editions.

[8] Wade Davis (2009). The Wayfinders: Why Ancient Wisdom Matters in the Modern World, Toronto : House of Anansi Press.

Our interest being mainly the built environment, we have consistently found environmentally-sensitive examples of systems, materials, building techniques and so on that represent a fundamental understanding of the nature of the environment that those people live in, common examples from the very south are the *Fougaras,* which are water systems around which societies are built and sustain themselves, revealing an innate ability to fundamentally understand local resources behavior (in this situation being water), and to structure society around the way it operates, that being alongside other adaptability factors like the use of local materials and techniques for comfort and energy efficiency.

What we see happen in those environments is a really good example of **local integration** [9]at a level beyond that of just energy and comfort, cultural and social notions aside. We can observe how we have learned to coexist with the natural world and work in tandem with natural elements to improve what already exists and thrive in a sustainable manner.

In that sense, the parallel to our current era requires an **ecologically motivated approach**[10], in a time where more than ever, the aim is to go beyond simplistic measures and actually integrate our own processes in the natural world (or in more precise terms, in our ecosystem) so that human processes can align with environmental processes, in that vein the question remains:

In order to integrate our own processes (human-driven usage of space) into local ecosystems, Can we use a method that relies on local natural conditions and features to orient our programming and planning practices?

III. GENERAL HYPOTHESIS:

1) Local natural conditions and features can be interpreted and used to orient our planning and programming practices to be more adapted to their environment as well as being more sustainable.

2) Interpretation of environmental data can provide better clues for design on multiple scales, but they cannot guide the design itself, in which case we resort to

[9] Richard Louv (2012). The Nature Principle: Human Restoration and the End of Nature-Deficit Disorder, Chapel Hill : Algonquin Books.

[10] Robert E. Ulanowicz (1997). Ecology: The Ascendent Perspective. New York : Columbia University Press.

normalized and scientifically confirmed procedures.

3) Data gathered from the environment can not only help shape the general program on a large city scale and give very accurate orientations, but is also an effective design tool to create architecture that is connected and integrated into a local ecosystem.

IV. GENERAL OBJECTIVES:

1) The first goal of the presented study methodology is to demonstrate that environmental data can be gathered, studied and translated in a rational and scientific manner to be laid out as a clear pattern of action toward sustainability

2) The second consists of proving that through understanding of underlying ecological systems, we are able to integrate architecture to participate within the natural, becoming an inherent part of it.

V. SPECIFIC PROBLEMATIC:

We have always had definite proof of the existence of Human-nature cooperation in terms of built environment, it is not a stretch to think of a way to read the natural environment as orientation data that can help us in our quest to make our environment more **''fit''**[11].

In our present context, which is the city of Bousaada, the unique location of it being a funnel of different environments that managed to exist in juxtaposition and superposition gives way to an incredible amount of conditions, opportunities and intrinsic values, which by virtue of being so multiple, allows for a huge variety in programmation across the board.

In that sense, it is in this exact environment that an example for local ecosystem integration must be set, once again when considering our past and still present examples of how we have managed to plug our system into what is already established, we can start considering various methods that have been used to further our understanding of the natural world and it's **parameters**[12], and the compatibility levels of our own programmatic needs.

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[11] Aldo Leopold (1949). The Land Ethic. In "A Sand County Almanac and Sketches Here and There." New York : Oxford University Press.

[12] György Doczi (1981). The Power of Limits: Proportional Harmonies in Nature, Art, and Architecture., Boston : Shambhala Publications.

Now within Bousaada itself, the most appealing but also the most critical location to consider in terms of value, whether it is the general intrinsic, social, economic, cultural, or even scientific values, is the oasis, the green heart of the city that suffers constant degradation at the hand of the locals, buildings damaging the fertile lands, whole parts of it being abandoned and not used for agriculture, the poor state of its own irrigation system due to being neglected, once again a prime example of **misuse of a local ecosystem**[13] which has not only great potential for usage all across the board, but is also vital if the locals are to survive.

For any intervention within an area like the oasis, an interesting approach to help visualize our planned interventions and the compatibility level with the existing natural environment, is that of a suitability analysis, being a data-driven process with information that is extracted from existing conditions, the latter being natural but also taking into account manmade parameters, that way, we not only have tools to know if our large-scale program is compatible with local conditions, but we also get a more clear read of what the land itself is compatible for, therefore knowing the most adapted, and fitting usage of land, in other words, the context itself with its natural, and manmade elements and parameters show us how to **achieve optimal environmental implementation**[14].

Now the question is:

With the current knowledge of Bousaada as a strategic position for ecological planning opportunity, <u>aiming at conservation and eco-sensitive integration within its fragile boundaries</u>, can we consider a form of intervention based on a suitability analysis that allows for clear recommendations within Bousaada's oasis,?

VI. SPECIFIC HYPOTHESIS:

We can indeed consider, with very sensible and careful study of the elements

[13] Jared Diamond (2005). Collapse: How Societies Choose to Fail or Succeed. New York : Penguin Books.

[14] Ian McCallum (2012). Ecological Intelligence: Rediscovering Ourselves in Nature., Cape Town : Random House Struik.

that make up the oasis, an intervention at the architectural scale as an example of how buildings can, and should be integrated within an existing ecosystem, while remaining in the ecosystem's set of rules.

VII. SPECIFIC OBJECTIVES:

The aim of is to prove the theory of how implementation within ecologically-sensitive areas is indeed possible within a set of rules, that architecture can become part of an ecosystem and derive it's principles from it, solidifying its own permanence and enhancing its surroundings in the process.

VIII. MOTIVATING FACTORS FOR THEMATIC CHOICE:

What motivates this topic specifically is not only fascination but also a sense of urgency regarding the topic, in our time ecology and environmentally-friendly have become a trend in daily life and mostly in the field of design and construction, but we attempt to co-exist with what we do not fundamentally understand, and it is only through the development of this vision of what our environment truly consists of, that we can understand exactly what needs be done, and not just go in general directions hoping for the best.

IX. MOTIVATING FACTORS FOR SITE CHOICE:

Bousaada is an emblematic city in our country, it resides at the limit of different environments, encompassing all the features that make each so unique, which makes it the perfect spot for ecosystem-related studies and interventions, the multiplicity of environments offers a case study to explore possibilities in one of the most challenging yet extraordinary examples of variety.

X. METHODOLOGICAL TOOLS:

In order to find adequate answers to our problem and questions, as well as to verify the hypotheses posed from the outset, we have opted for an approach that reconciles adequate methodological tools for our research subject.

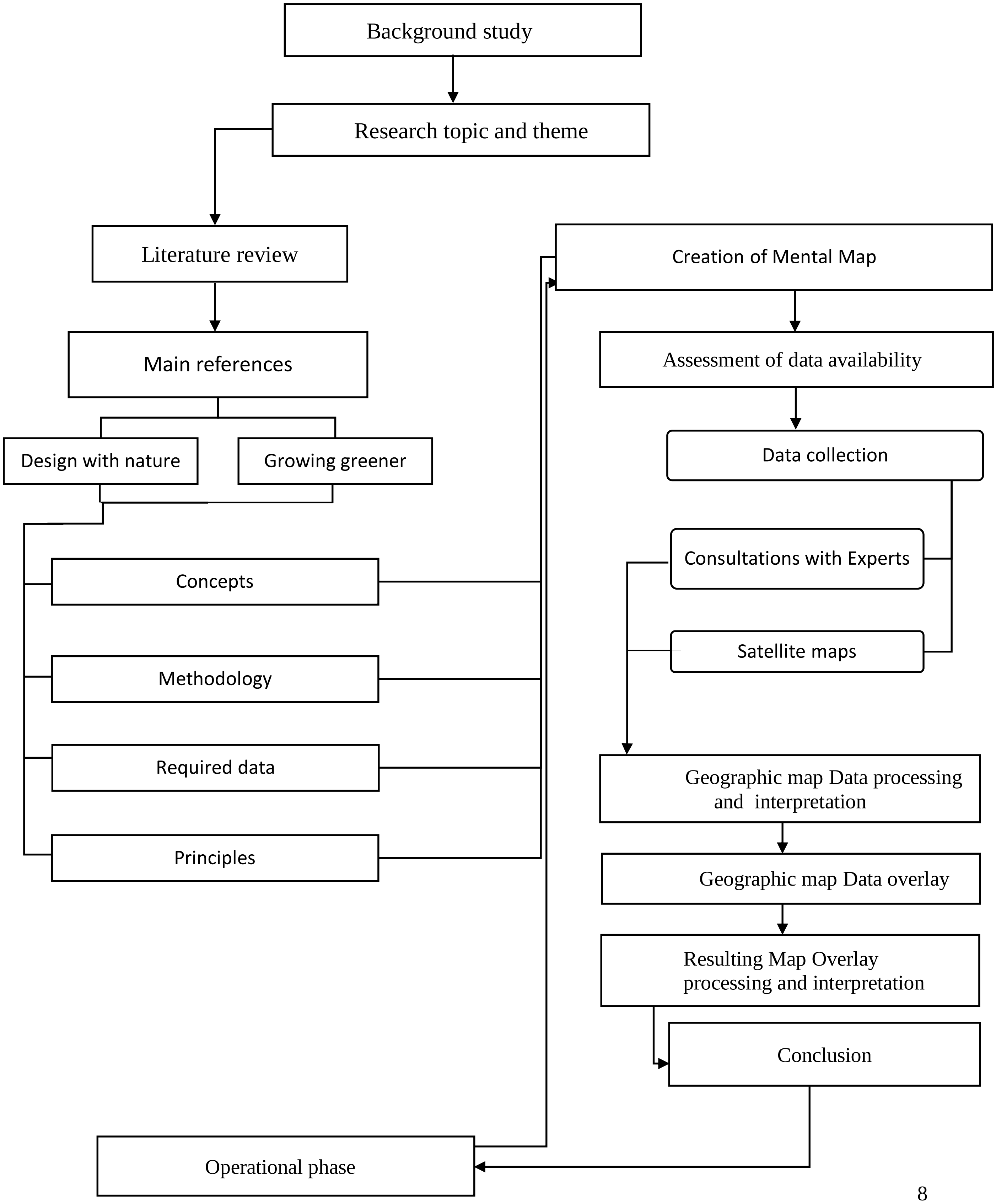
According to the outline adopted by our university, the work is Spread accros two chapters, as well as an introductory chapter, and an annex representing the one-off project part and possibly the development project. This will allow us to structure our ideas in such a way as to better explain the research subject, display the work context, ask questions and follow a coherent and adequate methodological approach with the research topic.

First and for a conceptual and theoretical approach, we tried to understand the Theoretical part, the literature review and the key concepts of our research. We have explained some concepts such as: Sustainable urbanism, urban project, Multi-layered Geographic map analysis, Conservation subdivision…….

Secondly, under an empirical and analytical vision, and more than the examples cited in the previous chapter (this is seen as a comparative analytical vision), we presented the city of Boussaada as a case study via a site and climatological analysis… in the context of dealing with our problematic objectively, we have applied the approaches mentioned in the theoretical part of our case study. This will lead directly to the proposal of a contextual urban project.

During our work, we took as scientific bases, books, articles, reviews and real examples. At the same time, we made site visits and worked on questions with the inhabitants of the city with the help of associations after having signed an agreement between our university and the APC of Boussaâda. This methodological approach led us in the end to propose a specific project which still reflects the mastery of the subject of the research.

XI. Research framework



CHAPTER 2:
Theoretical background

The aim of this chapter is to introduce and define terms relating, first and foremost, to our research topic. To this end, we have reviewed concepts related to urban planning, map superimposition and landscape reading. We have taken as references books by protagonists on the subject. In this respect, we have tried to establish a traceability of ideas as follows:

I. Urbanism and Environment

1. Urbanism

The utilization, regulation, and design of space in urban environments, with a focus on the social impacts, economic functions, and physical form, are encompassed by urbanism, also called urban planning. It is an interdisciplinary field that incorporates architecture, engineering, and social and political considerations. Consequently, urban planning is considered both a technical profession, an endeavor involving political will and public participation, and an academic discipline. Within its scope, the revitalization of existing urban areas and the development of open land ("greenfield sites") are included, necessitating goal setting, data analysis, forecasting, design, strategic thinking, and public consultation. A significant role in urban planning is played by architects, who contribute to the aesthetic and functional aspects of buildings, public spaces, and urban infrastructure.[15]

2. Types of Urbanism:

1) New urbanism / traditional urbanism : is an urban planning and design movement that emphasizes walkability, mixed-use development, and the revival of traditional neighborhood characteristics, promoting sustainable and community-oriented urban environments. People are at the center of urban design.
2) Re-urbanism : refers to the process of revitalizing and redeveloping existing urban areas, often focusing on brownfield sites or underutilized spaces, with the aim of creating vibrant and sustainable communities.
3) Post-urbanism : Post-urbanism is a theoretical framework that challenges the conventional understanding of urbanism, proposing a shift

[15] Encyclopedia Britannica

away from traditional urban forms and structures, and instead emphasizes the dispersal of urban functions, blurring the boundaries between urban and rural areas.

4) Everyday urbanism : is an approach that recognizes the importance of the ordinary and everyday activities of people in shaping urban environments, focusing on the small-scale, incremental changes that occur through individual actions and grassroots initiatives.
5) Sustainable urbanism / green urbanism : advocates for environmentally conscious and resource-efficient urban development, incorporating principles such as renewable energy, efficient transportation systems, green spaces, and sustainable building practices to create environmentally friendly and livable cities.

3. Urban project:

Defined as undertaking intentional and purposeful efforts to introduce architectural interventions within urban environments. It entails a systematic approach to transform and improve urban areas by addressing specific challenges and opportunities. Through research, planning, design, implementation, and evaluation, an urban project seeks to create positive impacts on the built environment and shape the urban fabric. It is a collaborative endeavor that engages various stakeholders, including urban planners, architects, engineers, policymakers, community members, and investors, working towards common objectives. By integrating architectural principles and urban design strategies, an urban project aims to realize vibrant, livable, and socially inclusive urban spaces, contributing to the revitalization, sustainability, and overall enhancement of cities.[16]

4. Environment:

In the field of environmental science, the notion of environment typically encompasses the natural and human-made surroundings that influence living organisms and their interactions. This includes the physical,

[16] Lang, J. (2005). Urban Design: A Typology of Procedures and Products. Architectural Press. United Kingdom.

biological, and chemical components of ecosystems, as well as the social, cultural, and economic factors that shape human-environment relationships. The study of the environment in this context involves understanding the interconnectedness of Earth's systems, the impact of human activities on the environment, and the pursuit of sustainable practices to protect and conserve natural resources.[17]

5. Natural Environment and Ecosystem:

a) Natural Environment:

Refers to all living and non-living entities that exist naturally on Earth or within a specific region.

The components of the natural environment can be distinguished as follows:

Complete ecological units that serve as natural systems without extensive human intervention, encompassing all vegetation, animals, microorganisms, soil, rocks, atmosphere, and natural phenomena occurring within their boundaries.

Universal natural resources and physical phenomena that lack distinct boundaries, such as air, water, and climate, as well as energy, radiation, electric charge, and magnetism, which are not derived from human activity.[18]

In the context of architecture, the natural environment plays a significant role. Architects consider the natural environment when designing buildings and structures to ensure harmonious integration with the surrounding landscape. They strive to create designs that respect and respond to the ecological systems, vegetation, and geological characteristics of the site. By considering the natural environment in architecture, sustainable design practices can be implemented, aiming to minimize environmental impact and enhance the overall quality and relationship between built structures and the surrounding natural elements.

b) Ecosystem

All the elements present within a specific environment are encompassed by

[17] Botkin, D. B., Keller, E. A. (2021). Environmental Science: Earth as a Living Planet (11th Edition). Wiley.
[18] Holden, J. (2017). An Introduction to Physical Geography & the Environment (4th Edition). Pearson Education Limited.

the term "ecosystem." This includes living entities such as plants and animals, as well as non-living elements like rocks, soil, sunlight, and water. The interconnectedness and interdependence of these components are represented by an ecosystem. For instance, the diverse life forms, natural resources, and environmental factors that exist within a forest constitute its ecosystem.[19]

II. Sustainability and Ecology

1. Sustainability:

The growing recognition of the environmental, social, and economic challenges associated with modern architecture and industry has prompted numerous business leaders and communities to adopt sustainable practices that prioritize long-term benefits. While these efforts aim to sustain commerce and employment, they also strive to reduce resource consumption, energy usage, and harmful emissions and waste. As a result, sustainability initiatives generally focus on improving the efficiency of existing industrial systems rather than fundamentally overhauling them. For architects who prioritize sustainability, this often means designing buildings that maximize energy and resource efficiency while minimizing waste.[20]

1. The four pillars of sustainability:

a. Social:

Social sustainability in the context of urbanism and architecture is crucial for preserving social capital and accommodating a broader perspective that encompasses communities, cultures, and globalization. It recognizes the potential impact of our actions on others and future generations. Fostering cohesion, reciprocity, and honesty, as well as valuing relationships among people, are central to enhancing social quality. This can be achieved through the support of laws, information dissemination, and shared ideas of equality and rights. Incorporating sustainable development principles, social sustainability in urbanism and architecture acknowledges the interdependence

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[19] Encyclopedia Britannica

[20] David Gissen, 2002, Big and Green: Toward Sustainable Architecture in the 21st Century, Princeton Architectural Press, P8

between social, economic, and environmental aspects, highlighting the mutual reliance of the economy, society, and ecological systems. Active involvement, such as investing in social infrastructure and creating inclusive spaces, along with passive considerations like preserving cultural heritage and promoting equitable access to resources, contribute to social sustainability. Ultimately, social sustainability in urbanism and architecture aims to create a framework that preserves social capital, acknowledges the global interconnectedness, and fosters well-being for present and future generations through an integrated approach.[21]

b. Human

Human sustainability in urban contexts encompasses key principles such as affordability and accessibility, ensuring that cities offer housing, services, and opportunities that are within reach of diverse socioeconomic groups. It also emphasizes social connectivity and community building, fostering a sense of belonging and social cohesion through well-designed public spaces, community facilities, and neighborhood planning. Environmental sustainability is another crucial aspect, advocating for resource efficiency, reduced pollution, and the integration of green spaces into the urban fabric. Additionally, economic diversity and resilience play a significant role, encouraging a varied economic base that supports multiple industries and entrepreneurial endeavors. By prioritizing inclusivity, well-being, and quality of life for all residents, the belief is that cities can become more sustainable, equitable, and livable through a holistic approach that addresses affordability, social connectivity, environmental sustainability, and economic diversity.[22]

c. Economic:

Economic sustainability in architecture and urbanism refers to the incorporation of design and construction practices that offer cost savings through energy efficiency, improved lifecycle performance, and reduced operating expenses. It involves considering the return on investment associated with sustainable features,

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[21] Diesendorf, M. (2000). Sustainability and Sustainable Development. In D. Dunphy, J. Benveniste, A. Dunphy, D, Benveniste, J, Griffiths, A and Sutton, P (eds) Sustainability: The corporate challenge of the 21st century, Sydney: Allen & Unwin, oui

[22] Joel Kotkin, (2016), The Human City: Urbanism for the Rest of Us, Agate Publishing, Chicago, Illinois, USA

such as lower energy costs and increased property values. Additionally, economic sustainability encompasses the utilization of financial incentives to offset upfront costs and make sustainable design economically viable. It recognizes the market demand for environmentally friendly buildings, providing a competitive advantage. Furthermore, it acknowledges the economic benefits of sustainable architecture, including job creation and contributions to local economic growth. By integrating these principles, architects and urban planners can create a built environment that balances environmental and economic well-being.[23]

d. Environmental:

Environmental sustainability refers to the set of concepts and ideas in architecture and urbanism that aim to achieve a harmonious coexistence between the built environment and the natural world. It encompasses strategies such as passive design, energy efficiency, and the integration of renewable energy sources. By emphasizing the use of sustainable building materials, energy-efficient systems, and environmentally conscious transportation solutions, it seeks to minimize the environmental impact of human activities. The principles of incorporating natural elements, such as sunlight, wind, and daylight, into architectural design play a crucial role in reducing resource consumption and promoting ecological balance. Through the adoption of green building practices, the efficient use of resources, and the reduction of carbon emissions, environmental sustainability strives to create a built environment that supports the long-term well-being of both human society and the natural ecosystems.[24]

2. Ecology:

Ecology is the scientific study of the relationships between organisms and their environment. It explores the interactions, dynamics, and interdependencies among living organisms, including plants, animals, and microorganisms, and their surrounding physical and biological environments. Ecology examines the distribution and abundance of organisms, their adaptations to different environmental conditions,

[23] Gregory H. Kats, (2010), "The Economics of Green Building"
[24] David W. Orr, 2004, Earth in Mind: On Education, Environment, and the Human Prospect, Island Press, Washington, D.C., United States.

and the flow of energy and matter through ecosystems. It encompasses various levels of organization, from individuals and populations to communities and ecosystems. The field of ecology plays a crucial role in understanding the complex interactions and processes that shape the natural world and contribute to the conservation and sustainable management of our planet's biodiversity and ecosystems.[25]

3. Ecological Design:

Ecological design encompasses a holistic and systems-based approach to shaping the built environment in harmony with nature. It recognizes the interconnectedness of ecological systems, human activities, and the built infrastructure, aiming to create sustainable and regenerative solutions. Ecological design emphasizes the integration of ecological principles, such as biodiversity, energy efficiency, and resource conservation, into the design and planning process. It seeks to minimize the negative environmental impacts of development while maximizing positive outcomes, fostering resilience, and promoting long-term ecological health. By embracing natural patterns, processes, and functions, ecological design strives to create harmonious and symbiotic relationships between human systems and the natural world, resulting in thriving, balanced, and resilient built environments that support both human well-being and the health of the planet.[26]

4. Sustainability as a notion in Architecture and Urbanism:

A. In Urbanism:

1) Green Urbanism
2) Sustainable Urbanism:

The concept is rooted in recognizing environmental hazards but it also involves a collaborative effort to balance ecological, economic, and social considerations. This idea is closely aligned with the fundamental principles of environmental law:

1) precaution
2) prevention
3) remedy at source

[25] Molles, M. C., Jr. (2019). Ecology: Concepts and Applications (9th ed.). McGraw-Hill Education. New York, NY, USA.
[26] Thompson, G. F. (1997). Ecological Design and Planning. Wiley. New York, USA.

4) "polluter pays"
5) Use of the best available technology[27]

3) Ecological Urbanism:

Ecological urbanism is inspired by ecology to create an environmentally sensitive and socially inclusive form of urbanism. It goes beyond the ideological aspects of green urbanism or sustainable urbanism. Landscape Urbanism is critiqued and seen as an evolutionary step towards a more holistic approach to city design and management. This urbanism focuses on compactness, complexity, efficiency, and stability as key objectives. By intertwining sustainability and urban occupation models, ecological urbanism addresses the current environmental challenges of society.[28]

a) Objectives of Ecological Urbanism:

The creation of "artificial ecosystem" cities with interdependent efficiencies and life-preserving redundancies, similar to natural ecosystems, is the objective of Ecological Urbanism. In this approach, the linear pattern of energy intake and waste output is transformed into a closed loop, where waste is converted into energy. The focus on environmental systems entails a distinct perspective on the city, where urban sites are considered not only as places of resource demand but also as suppliers of resources.[29]

b) Principles of Ecological Urbanism:

a) Well-designed compact, mixed-use, and walkable neighborhoods, integrating habitat features at various scales, have the potential to combat urban sprawl and foster nature within the core of a city.
b) The absence of traditional greenspace in densely populated urban environments can be mitigated by implementing green infrastructure that emphasizes high

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[27] Dominique Gauzin-Müller, 2002, Sustainable Architecture and Urbanism: Concepts, Technologies, Examples, P13
[28] Miguel Ruano, 1998, Eco-Urbanism: Sustainable Human Settlements, 60 Case Studies, Watson-Guptill Pubns.
[29] Susannah Hagan, 2015, Ecological Urbanism, The Architectural Review.

connectivity, naturalness, and structural diversity at building, neighborhood, and city levels.

c) Empowering individuals who benefit from healthy urban ecosystems to shape the planning and design decisions that affect them is vital for achieving positive outcomes.

B. <u>In Architecture:</u>

1) Ecological Architecture:

Also known as Ecodesign, is a design methodology that focuses on the environmental impact of a product or service throughout its entire lifecycle. According to Sim Van der Ryn and Stuart Cowan, ecodesign involves designing products and services in a way that minimizes their harmful effects on the environment by incorporating living processes into the design.[30]

2) Environmentally Progressive architecture:

A novel strategy that has been adopted by planners and architects for promoting resilience and sustainability in their projects. This method entails creating spaces and implementing processes that work in harmony with ecological systems to support and enhance them. The ultimate goal of ecological design is to minimize adverse impacts on the environment while also promoting the long-term health and well-being of both people and the natural world.[31]

5. <u>Unsustainable Urbanization:</u>

1) What is Unsustainable Urbanization?

Any form of Urbanization that aggravates environmental degradation, as well as creates Unnecessary costs, Puts People at risk, and is intrinsically unfair, The patterns of Unsustainable Urbanization are Rapid, Unplanned and Sprawling Development of land, characterized by major misuse and management of resources.[32]

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[30] Van der Ryn S, Cowan S(1996). "Ecological Design". Island Press, p.33

[31] Coplan, Karl S., Green, Shelby D., Fischer Kuh, Katrina, Narula, Smita, Rábago, Karl R., Valova, Radina, (2021), "Climate Change Law: An Introduction", Edward Elgar Publishing, P89

[32] Aisa Kirabo Kacyira, (2012), 'Addressing the sustainable urbanization challenge'', UN-chronicle, Volume 49, Issue 2

III. ***Multi-layered Geographic Map Analysis as an alternate model for defining optimal land use in Urban Developments:***

The first approach to this study is that of Ian L.Mcharg's layer cake method[33], in simple terms it consists of gathering data in the form of maps with distinct categories for each map and data type, then overlaying all the different maps and interpreting the results to create a synthesis map, the goal of this is to take into account all the local conditions, opportunities and constraints existing from natural and social environments, to then decide the best course of action for an intervention.

This method is important in the sense where the destruction or misuse of local natural resources can be very damaging in the long term, as everything happening within it is part of a one continuous cycle encompassing a multitude of processes that humans are a part of, and so in disrupting the equilibrium of a local ecosystem by forcing human presence upon it in ways that harm the natural processes that occur, we endanger our own permanence in it.

A first example of this methodology has been tested on the jersey shore road, where the goal is to first present a simpler variant of the superimposition (or overlay) method used and the benefits from operating in a way that, beyond just thinking of connecting of two dots: point A To point B, aims to build in a way that increases a highway's value while costing the least in terms of building cost but also social costs.[34]

In that vein, the aim is to increase public and private benefits as listed under:

- Increasing the facility, convenience, pleasure and safety of traffic movement
- safeguarding and enhancing land, water, air and biotic resources
- Contributing to public and private objectives of urban renewal, metropolitan and regional development.
- Generating new productive land uses and sustaining or enhancing existing ones.

The methodology itself consists of gathering two main types of data:

1) A collection of maps that represent physiographic obstructions, or in other

[33] Paul Cureton, Strategies for Landscape Representation: Digital and Analogue Techniques, Stoodleigh, Devon, UK,2017, P26.

[34] Ian Mcharg(1969), Design with nature, NY: Natural History Press in Garden City.

words the “engineer’s’’ maps, those are represented by:

- **Slopes.**
- **Surface drainage.**
- **Soil drainage.**
- **Bedrock foundation.**
- **Soil foundation.**
- **Susceptibility to erosion.**

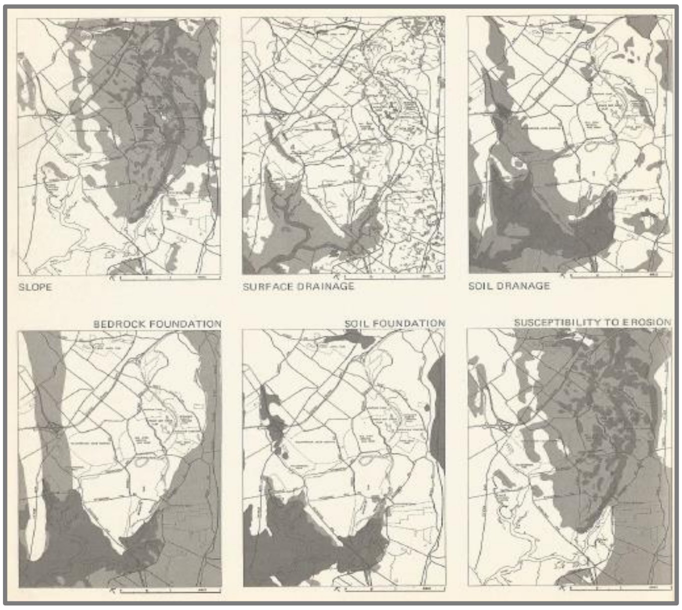


Figure 1: Engineering Values Maps, Source: Ian Mcharg (1969)

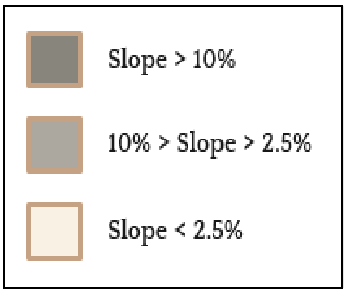


Figure 3: Breakdown of slope composition relative to gradients. Source: Ian Mcharg (1969).

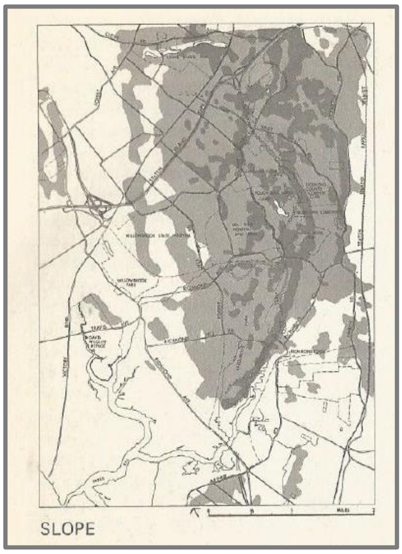


Figure 2: Slopes map. Source: Ian Mcharg (1969).

The Data of each map is broken down into 3 ranks, from most to least depending on the feature itself, as an example: slopes data is comprised of three different ranks, slopes above 10%, slopes between 10% and 2.5% and slopes that are less than 2.5%, the highest rank feature is highlighted in black, the medium one in gray and the lowest one in white, creating a gradient indicating different slope inclinations:

2) A collection of maps that represents **social values**, which are comprised of:

- **Land values**
- **Tidal inundation**
- **Historic values**
- **Scenic values**
- **Recreation values**
- **Water values**
- **Forest values**
- **Wildlife values**
- **Residential values**
- **Institutional values**

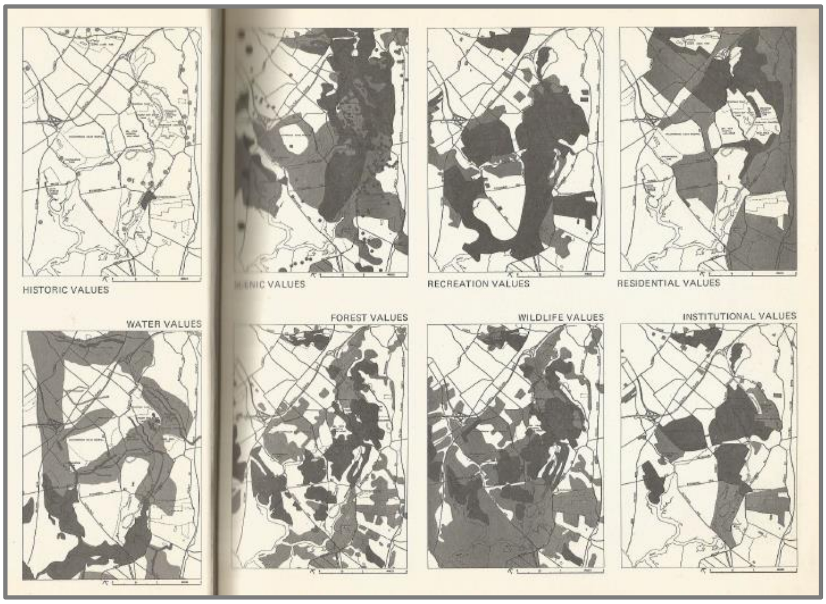


Figure 4: Social values maps. Source: Ian Mcharg (1969).

The same process occurs here, the different values are ranked in threes, from most to least, depending on the parameter, a general takeaway is that the darker areas are those of highest values, while lighter ones represent those of lowest value:

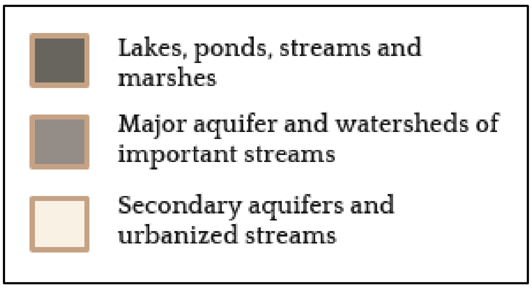


Figure 5: Breakdown of different water values composition relative to gradients. Source: Ian Mcharg (1969).

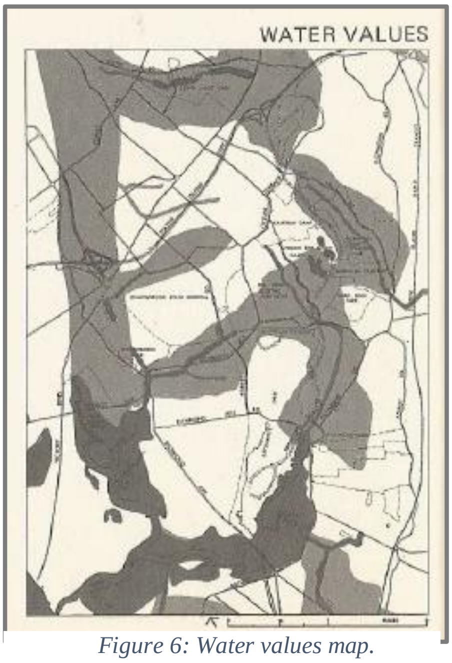


Figure 6: Water values map. Source: Ian Mcharg (1969).

Following the data collection phase, each of the data sets are superimposed individually, producing two different composite maps, one for physiographic obstructions, the other for social values.[35]

These maps can offer an indication of the general areas which are both of least social value, and building obstructions, giving a better idea of how to proceed in a way that has the least social and economic cost, for the most social and economic benefit.

These maps can offer an indication of the general areas which are both of least

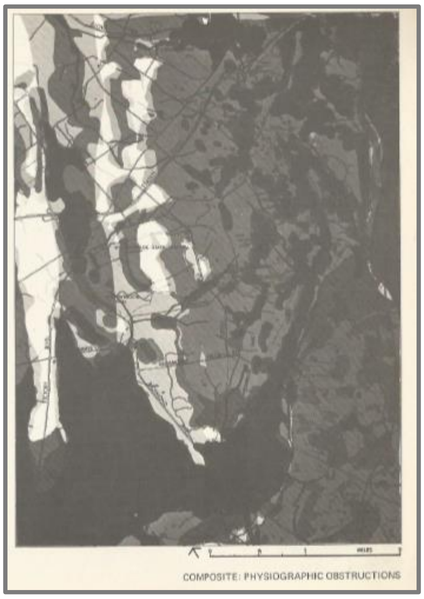


Figure 7: Composite Map: Physiographic consitictions. Source: Ian Mcharg (1969).

Figure 8: COmposite map: All social values. Source: Ian Mcharg (1969).

social value, and building obstructions, giving a better idea of how to proceed in a way that has the least social and economic cost, for the most social and economic benefit:

[35] Ian Mcharg(1969), Design with nature, NY: Natural History Press in Garden City, P 40.

A synthetic map is produced combining evaluations of both the physiographic obstruction and social value maps, which are then interpreted into a recommendation map that proposes different alignments that offer the least social cost and the most economic benefit[36]:

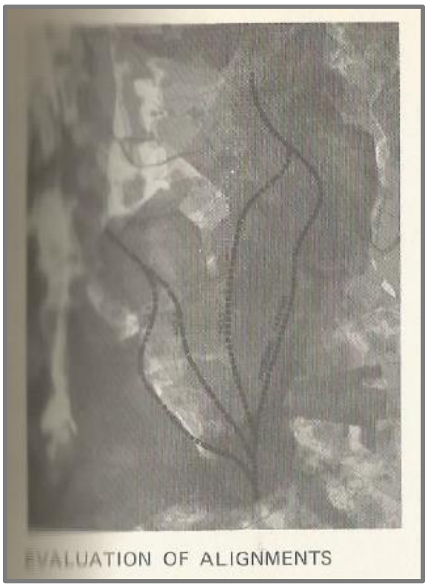


Figure 9: Evaluation of Alignments. Source: Ian Mcharg (1969).

Figure 10: Recommended minimal social cost alignment map. Source: Ian Mcharg (1969).

Second example

the Philadelphia metropolis is one where this method has been used to propose an open space planning.

This time the features selected to be mapped out are in order:

[36] Ian Mcharg(1969), Design with nature, NY: Natural History Press in Garden City, P 41.

- Surface water
- Marshes
- Floodplains
- Aquifer Recharge Areas
- Aquifers
- Steep slopes
- Forests, Woodlands
- Flat land

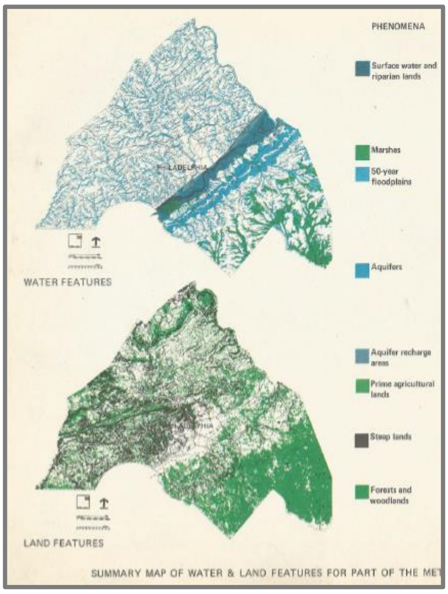


Figure 11: Existing values maps. Source: Ian Mcharg (1969).

These features are ranked from least to most tolerant to human usage, with the exception of the conflict when it comes to flat land, as it is ranked as the most tolerant but flat lands happens to also be the most suitable for agricultural production, knowing this the flat lands that are considered prime agricultural land will be classified as least tolerant, while those of low agricultural quality will be very tolerant.[37]

Each feature has a certain degree of tolerance, but there also is another study that aims at categorizing those features further, in terms of natural processes that:

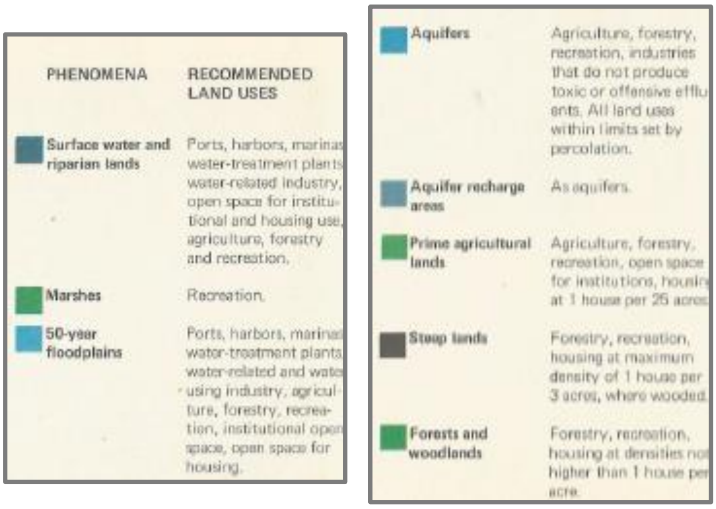
- **Perform work for man:** Natural water purification, atmospheric pollution disposal, climatic amelioration, water storage, flood, drought and erosion control etc…
- **Offer protection/are hostile:** Important areas of geological, ecological and historic interest.
- **Are Unique, Precious or Vulnerable:** beach dunes, spawning and breeding grounds, water catchment areas.

The result of the study of phenomena and its ranks, coupled with a compatibility study, culminates in a synthesis map that indicates phenomena and recommended land uses for it, examples are as follow:

[37] Ian Mcharg(1969), Design with nature, NY: Natural History Press in Garden City, P 57.

- **Surface water and riparian lands:** Ports, harbors, marinas, water-treatment plants, water-related industry, Open space for institutional and housing use, agriculture, forestry and recreation
- **Marshes:** recreation
- **Aquifers:** Agriculture, forestry, recreation, industries that do not produce toxic or offensive effluents, all land uses within limits set by percolation.
- **Steep lands:** Forestry, recreation, housing at maximum density of 1 house per 3 acres, where wooded.[38]

The understanding and mapping out of existing values has allowed for a comprehensive zoning recommendation chart based on natural phenomena, certain types of areas are assigned certain activities or land usage that is compatible to that area's properties and resources following the model:



PHENOMENA	RECOMMENDED LAND USES
Surface water and riparian lands	Ports, harbors, marinas, water-treatment plants, water-related industry, open space for institutional and housing use, agriculture, forestry and recreation.
Marshes	Recreation.
50-year floodplains	Ports, harbors, marinas, water-treatment plants, water-related and water using industry, agriculture, forestry, recreation, institutional open space, open space for housing.
Aquifers	Agriculture, forestry, recreation, industries that do not produce toxic or offensive effluents. All land uses within limits set by percolation.
Aquifer recharge areas	As aquifers.
Prime agricultural lands	Agriculture, forestry, recreation, open space for institutions, housing at 1 house per 25 acres.
Steep lands	Forestry, recreation, housing at maximum density of 1 house per 3 acres, where wooded.
Forests and woodlands	Forestry, recreation, housing at densities not higher than 1 house per acre.

Figure 12: Phenomenon/recommended land usage propositions. Source: Ian Mcharg (1969).

Third example:

Staten Island, where the same pattern of parameter study is applied, given yet another set of parameters which include:

[38] Ian Mcharg(1969), Design with nature, NY: Natural History Press in Garden City , P 58.

Bedrock geology, Surficial geology, Hydrology, Soil drainage environments, Existing land use, Historical landmarks, Tidal inundation, Physiographic features, Geological features, Slope, Existing vegetation, Existing wildlife habitats, Forest: existing quality, Forest: existing ecological association, Soil limitations: foundations, Soil limitations: water table, Historic features value, Existing forest quality, Marsh quality, Beach quality, Stream quality, Water wildlife value, Intertidal habitat, Geologic features, Soils: most to least erosion, Soils: least to most erosion, Physiographic features value, Scenic value (land), Scenic value (water), Ecological association value.

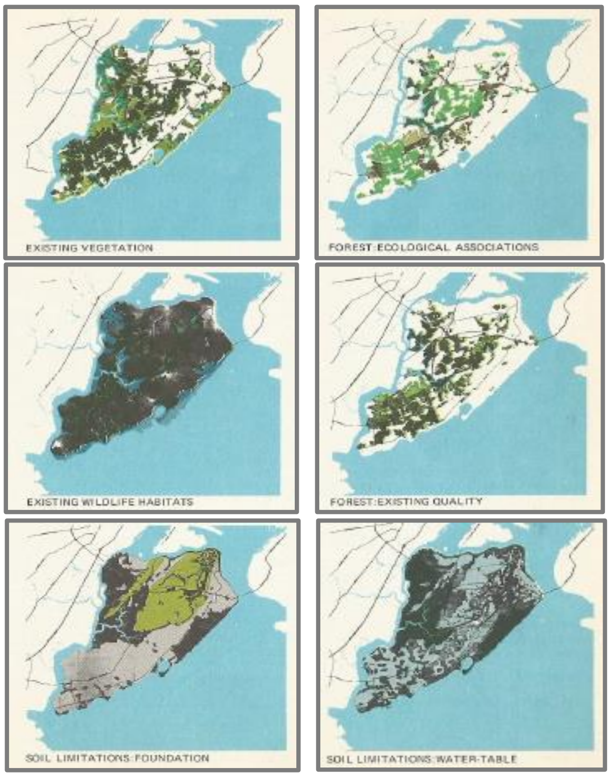


Figure 13: Slopes, Existing vegetation, Ecological associations, Existing wildlife habitats, Existing forest quality, Soil limitations: foundations and water table maps. Source: Ian Mcharg (1969).

These are devided in two sets of data, the first, once again represent the "engineer's" maps:

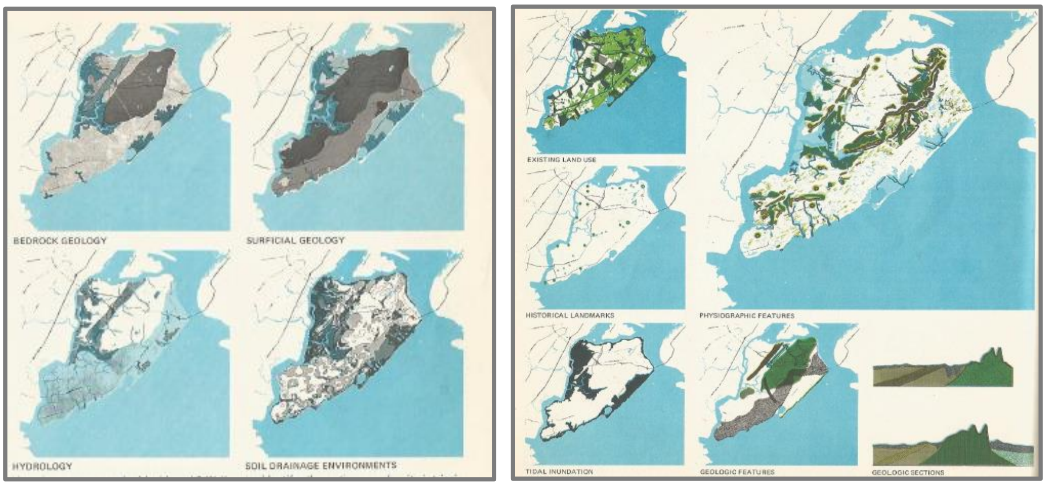


Figure 14: bedrock, surficial geology, hydrology and soil drainage environments, Historical Landmarks, Physiographic features, Tidal inundation, Geological features and sections maps. Source: Ian Mcharg (1969).

The second representing the "social values" maps:

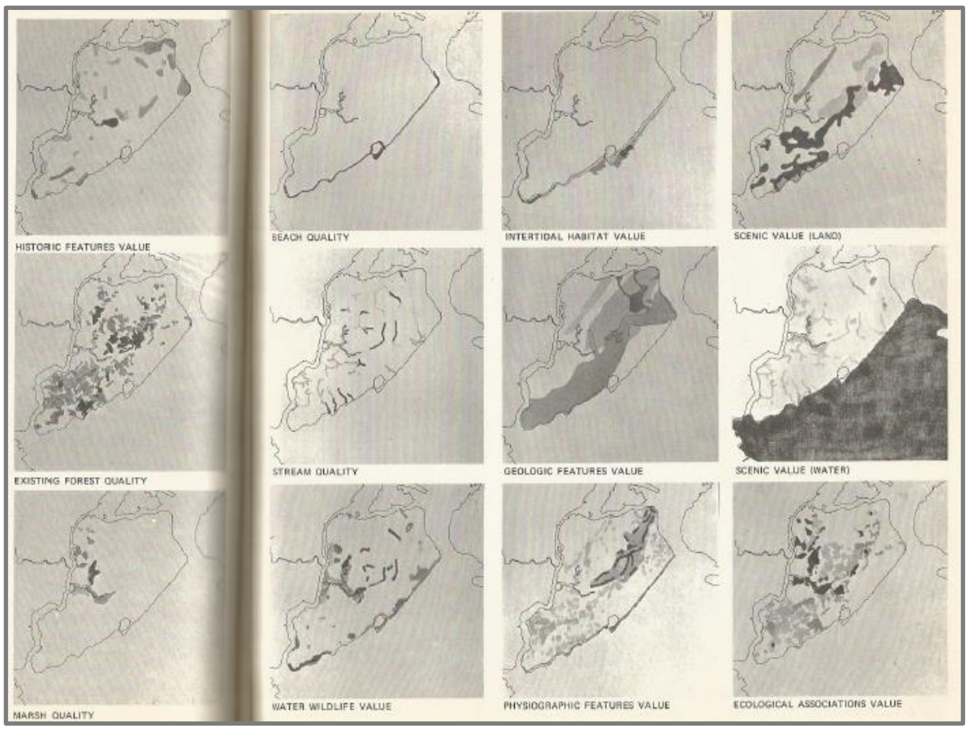


Figure 15: Collection of maps containing different social values Source: Ian Mcharg, 1969

Results of data study and superposition results in a map of conservation sites, which are high priority sites that represent valuable natural features/resources.

Other sets of maps can be produced from data interpretation based on set criteria, including **Recreation** and **urbanization** areas, as well as a secondary set of maps for **Active recreation suitability, Passive recreation suitability, Residential suitability, and Unsuitability for urbanization.**[39]

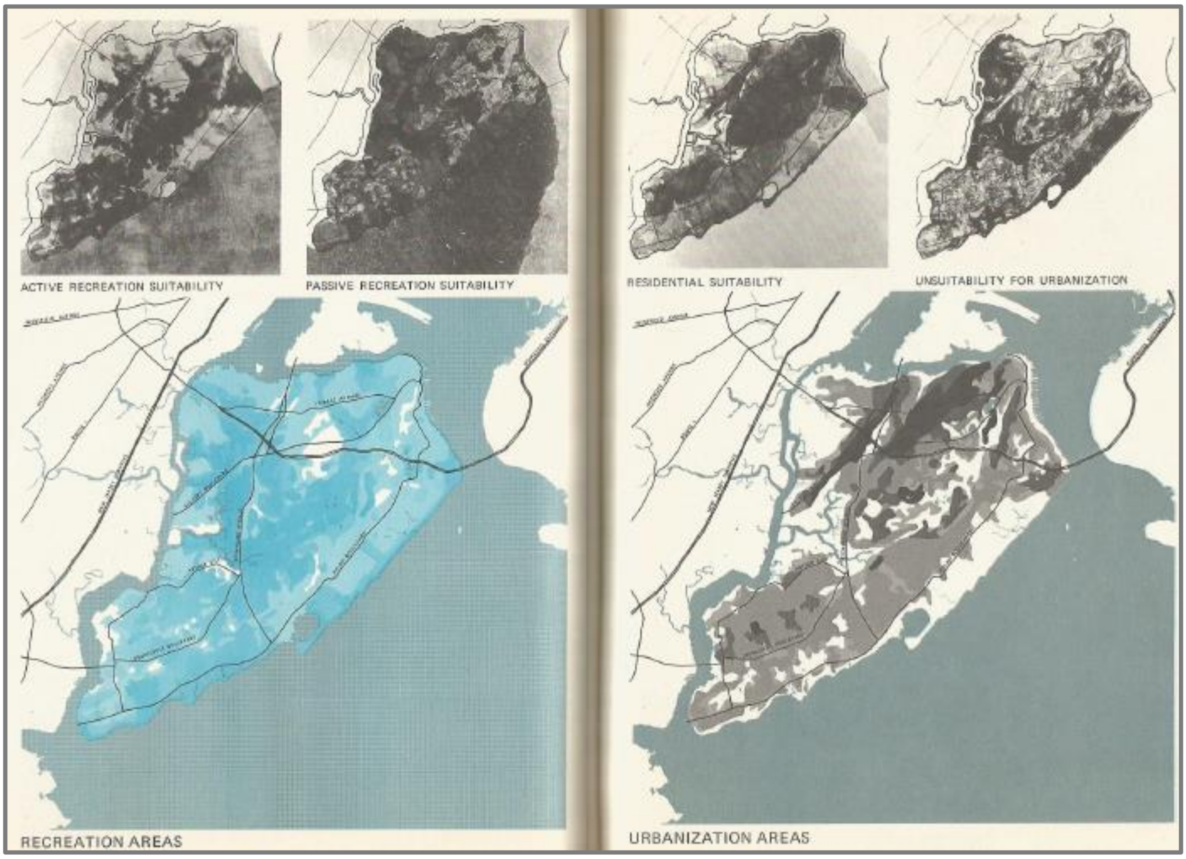


Figure 16: Collection of maps for different types of suitability

Source: Ian Mcharg (1969).

Each factor is mapped out following certain types of areas, for Passive Recreation:

- **Unique physiographic features,Scenic water features, streams,High quality forests,Features of historic value, High quality marshes, Scenic land features, Scenic cultural features, Unique geological features, Scarce ecological associations, Water-associated wildlife habitats, Water-**

[39] Ian Mcharg(1969), Design with nature, NY: Natural History Press in Garden City, P 105-115.

associated wildlife habitats, Water-associated wildlife habitats, Water-associated wildlife habitats, Field and forest wildlife habitats.

For Active Recreation :

- **Bay beaches,Expanses of water for pleasure craft, Fresh water areas, Riparian lands**, **Flat lands, Existing and potential recreation areas**.

For commercial-industrial use:

- **Good soil foundations**, **Good bedrock foundations**, **Navigable channels**

Restrictive factors are:

- **Slopes, Forested areas**, **Poor surface drainage**, **Poor soil drainage**, **Areas susceptible to erosion, Areas subject to flooding.**[40]

An important component of the classification is the following chart:

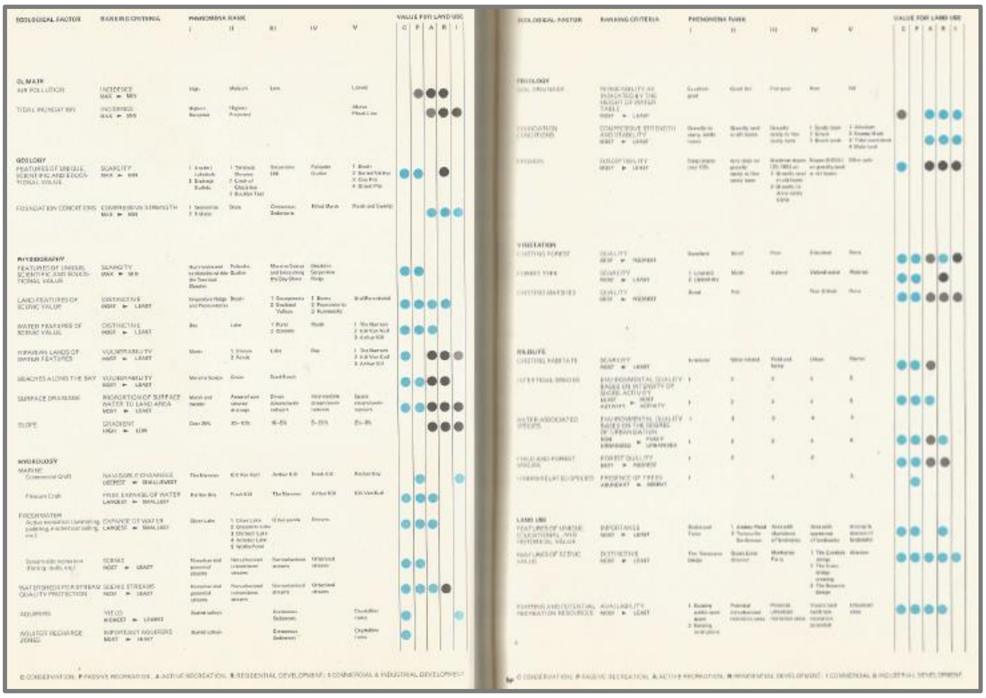


Figure 17: Detailed chart of location suitability based on the rank of values. Source: Ian Mcharg, (1969).

The chassification chart above Presents different factors broken down into five ranks:

the ranking system is based on individual criteria, for example:

[40] Ian Mcharg(1969), Design with nature, NY: Natural History Press in Garden City , P 112-113.

scarcity/incidence/vulnerability…etc, the values are based on five distinct land uses: Conservation, Passive recreation, Active recreation, Residential development, Commercial and Industrial Development, blue dots indicating an order from left to right, while black dots idicate the reverse order for priority, the intensity of the colour grades factor

importance, where more intense shades of black and blue are present are where the factors are strongest in terms of importance.

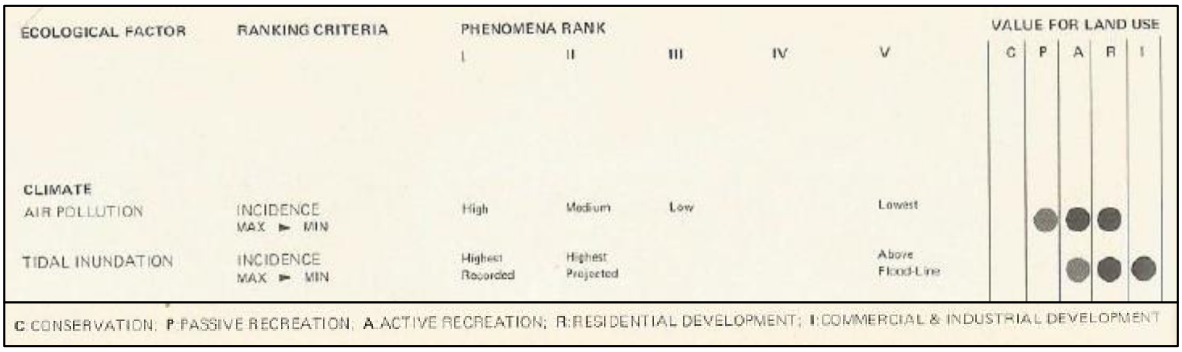


Figure 18: Example of single row of ecological factor taken into consideration.

Source: Ian Mcharg, (1969).

In addition to the chart, to deal with the multiplicity of land usage, as in the

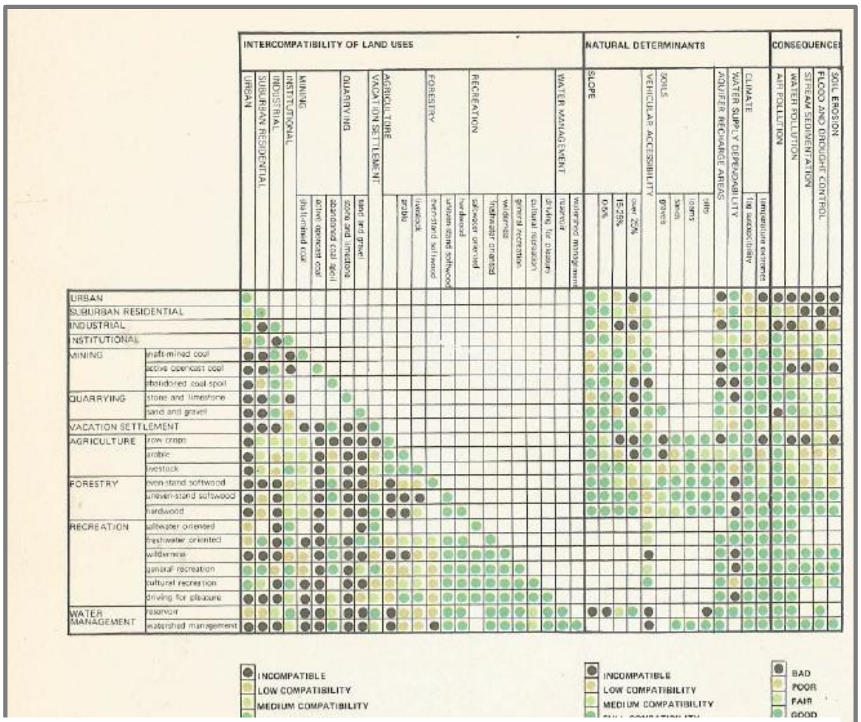


Figure 19: Chart of compatibility. Source: Ian Mcharg, (1969).

overlapping of multiple potential uses for land, we proceede by using a compatibility chart:

IV. ***<u>Conservation Subdivisions As an alternative to traditional modes of Land usage and Uncontrolled Development:</u>***

The growing greener method is an approach for shaping city growth, based on the idea that there are better ways to design new residential developments, the premise is simple: build so that only 50% (or less) of buildable area is consumed by house lots and streets, and thus avoid consuming important natural resources and converting them into bland, unproductive suburban lawns, When it comes to the Growing greener approach, there are two main layers: conservation zoning, and conservation subdivision design.

The introduction to the approach consists of an audit, which helps evaluate probable effectiveness of a community's regulatory and non-regulatory tools in achieving its land conservation goals.

The audit is comprised of three consecutive steps:

- A NUMERICAL ANALYSIS : which is comprised of growth projection, numbers of dwellings to be planned etc…
- A WRITTEN EVALUATION : represents evaluation and recommendations of land use regulations
- BUILT-OUT MAPS : which consists of maps of future development pattern.[41]

<u>1) NUMERICAL ANALYSIS:</u>

The main objective of performing a numerical analysis is to predict the amount of farmland or woodlands that may be converted into suburban areas within the next 10 to 20 years in the evaluated community.

To achieve this goal, various numerical data are analyzed to comprehend and forecast the significant growth trends that are currently taking place. It is important to carry out this analysis on a wide-area scale, by identifying the acreage and percentage

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[41] Randall G. Arendt, (1999), Growing Greener: Putting Conservation into Local Plans and Ordinances, Washington DC: Island press., P 9-14.

of the community's developed and undeveloped land and comparing these figures with data from other nearby municipalities.

Additionally, it is crucial to perform a similar comparative analysis of recent and expected growth trends such as population increase, new housing construction, and land conversion to developed areas.

2) WRITTEN EVALUATION :

The second stage involves a comprehensive examination of the community's existing land-use plans and regulations, as well as a review of non-regulatory initiatives undertaken by the municipality and private conservation groups. The objective of this review is to assess the effectiveness of the current codes in achieving the municipality's resource land conservation goals. In other words, the auditor aims to identify any deficiencies or constraints in the regulations that may impede or limit the implementation of effective conservation design, and to provide constructive recommendations for specific improvements in the language of the regulations.

3) BUILD-OUT MAPS:

The build-out map is a highly effective tool that is both affordable and easy to understand. It helps local officials and residents comprehend the future outcomes of adhering to current land-use codes. This technique involves creating maps that display the probable locations of new houses and streets that could be built on vacant land within the municipality. In short, build-out maps provide a realistic projection of future development possibilities.

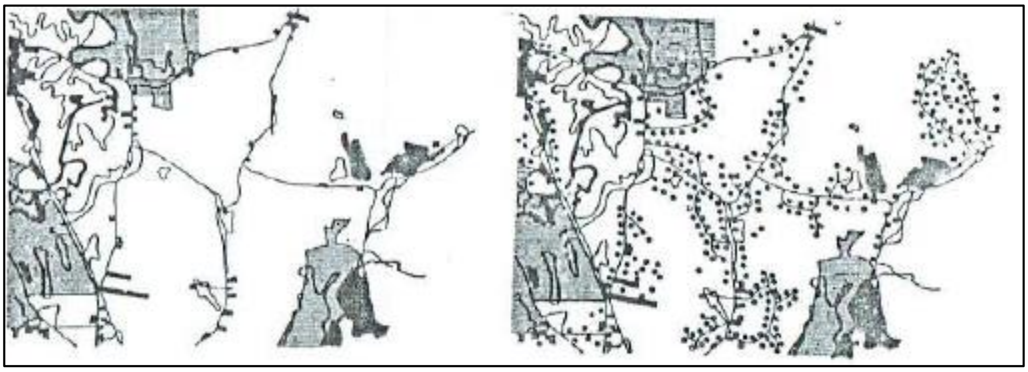

Figure 20: Build-out maps representing undeveloped land.. Source: Randall G. Arendt, 1999

After that, the operational layout consists of four distinct steps, which are:

1) IDENTIFYING CONSERVATION AREAS

2) LOCATING HOUSE SITES

3) ALIGNING STREETS AND TRAILS

4) DRAWING LOT LINES[42]

The next part of the intervention consists of preparing a community resource inventory map, which includes:

- Wetlands and floodplains, Slopes, Soils, Significant Wildlife Habitats, Woodlands, Farmlands, Historical, Archaeological, and Cultural features, Views into and out from the site, Groundwater Recharge areas.[43]

1) IDENTIFYING CONSERVATION AREAS

Once the features are collected, they need to be prioritized for conservation. Typically, designated open spaces encompass wetlands, floodplains, slopes, and soils, which are legally regarded as areas that cannot be built on. Moreover, these areas are crucial environmental resources with high sensitivity, making them the top priority for conservation efforts, they are primary conservation areas.

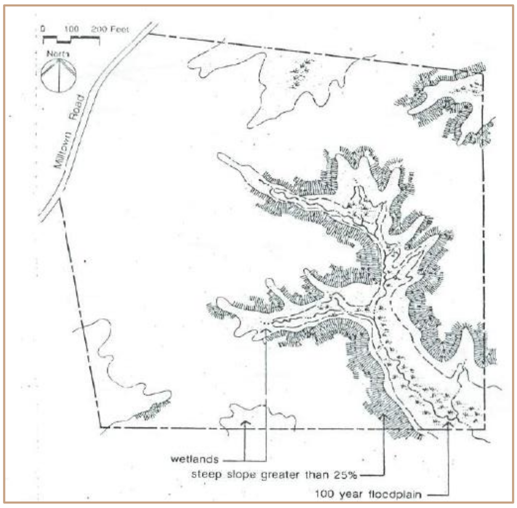

Figure 22: Primary Conservation Areas map. Source: Randall G. Arendt, 1999

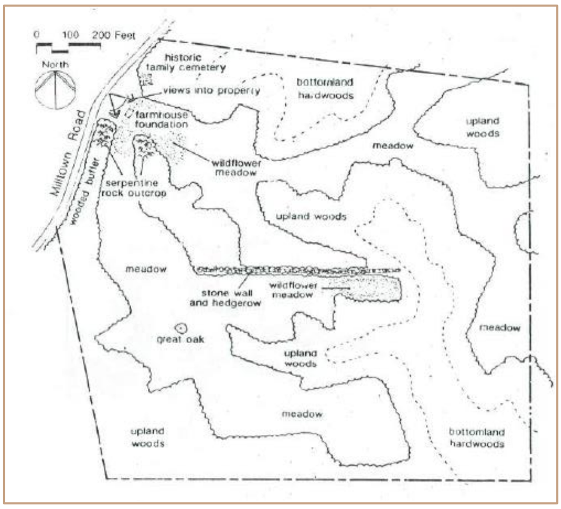

Figure 21: Secondary Conservation Areas map. Source: Randall G. Arendt, 1999

[42] Randall G. Arendt, (1999), Growing Greener: Putting Conservation into Local Plans and Ordinances, Washington DC: Island press,P 65.

[43] Randall G. Arendt, (1999), Growing Greener: Putting Conservation into Local Plans and Ordinances, Washington DC: Island press,P 22.

The priority of other resources is determined by their distinctive features, irreplaceability, environmental significance, as well as their historical or scenic value. These factors are taken into account to create a secondary conservation areas map that includes all relevant information. [44]

2) LOCATING HOUSE SITES

Once the Primary and Secondary conservation areas have been identified, the remaining areas are evaluated to determine the most appropriate locations for residential plots and streets. These areas are referred to as potential development

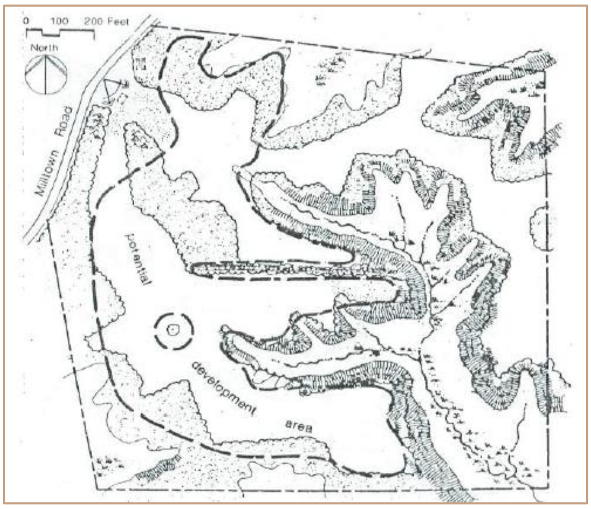

Figure 23: Potential Development Areas. Source: Randall G. Arendt, 1999

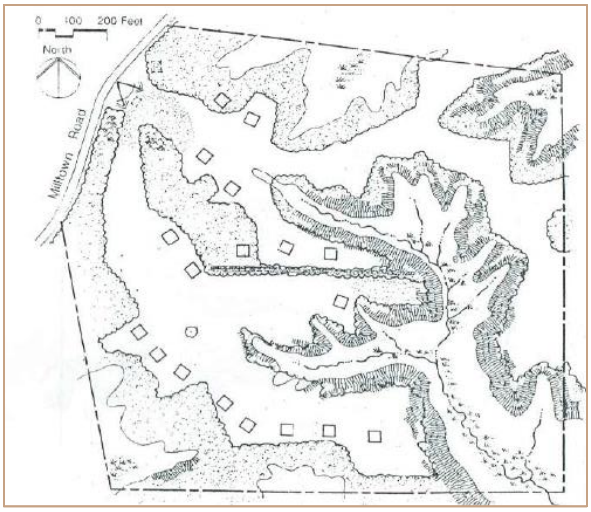

Figure 24: House sites locations. source: Randall G. Arendt, 1999

areas. What follows next is the laying of house locations, such as a maximum number of homes can have direct views of the areas that have been conserved[45].

3) ALIGNING STREETS AND TRAILS

[44] Randall G. Arendt, (1999), Growing Greener: Putting Conservation into Local Plans and Ordinances, Washington DC: Island press,P67-68.

[45] Randall G. Arendt, (1999), Growing Greener: Putting Conservation into Local Plans and Ordinances, Washington DC: Island press. P 69.

Next comes in Aligning Street Trails, This can better be described as a game of ''connecting dots'', the objective being finding the most efficient way to connect every single house to the street system, parameters are taking into account like slopes/topography and wetlands, which pose technical, cost and engineering issues, but also wildlife habitats, large trees and valuable features which also pose environmental issue, other recommendations are taken into account like:

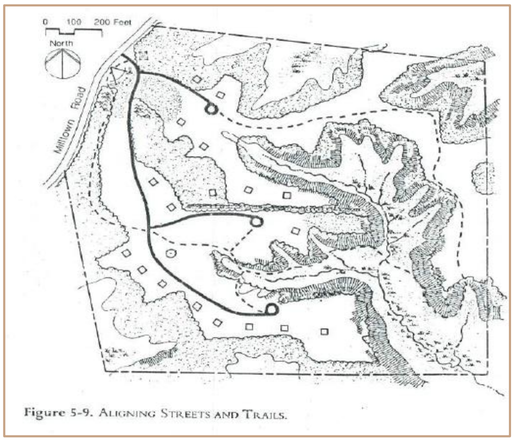

Figure 25: Streets and trails Alignment proposition. Source: Randall G. Arendt, 1999

Avoiding Long Straight Segments, Providing "Terminal Vistas", Introducing "Reverse Curves", Using **Single Landings, Using "T" Intersections.**[46]

4) DRAWING LOT LINES

Final and easiest step on the list, representing the least important element in the development design process, it consists of drawing the limits of individual house lots:[47]

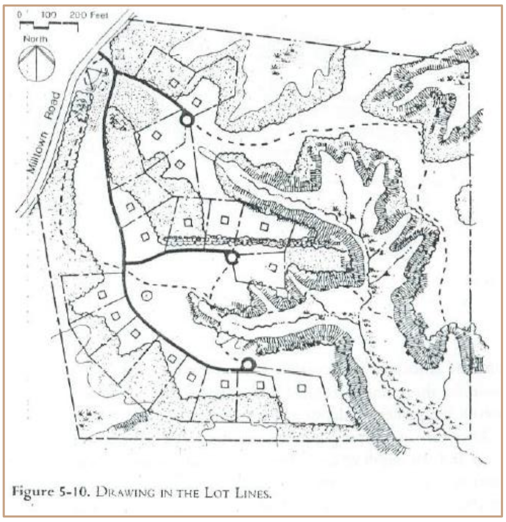

Figure 26: Lot lines plan. Source: Randall G. Arendt, 1999

[46] Randall G. Arendt, (1999), Growing Greener: Putting Conservation into Local Plans and Ordinances, Washington DC: Island press., P 70.

[47] Randall G. Arendt, (1999), Growing Greener: Putting Conservation into Local Plans and Ordinances, Washington DC: Island press P 71.

PRINCIPLES FOR CONSERVATION SUBDIVISIONS:

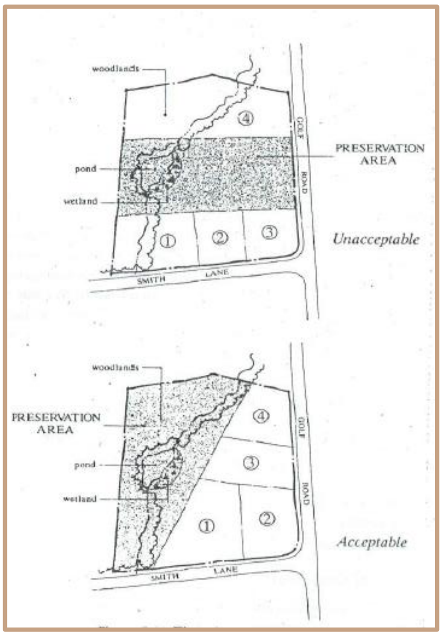

Figure 29: Most valuable area located in Conservation Subdivision. Source: Randall G. Arendt, 1999.

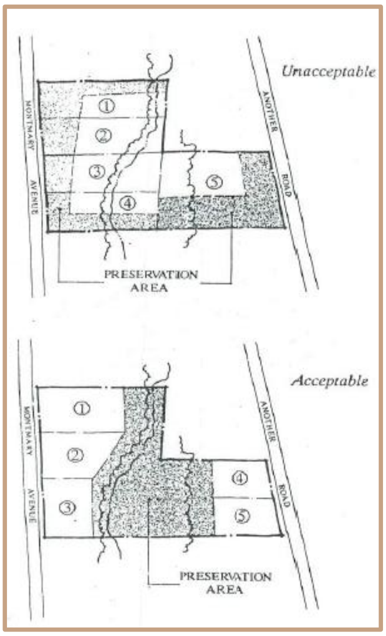

Figure 28: Minimal fragmentation of conservation areas. Source: Randall G. Arendt, 1999.

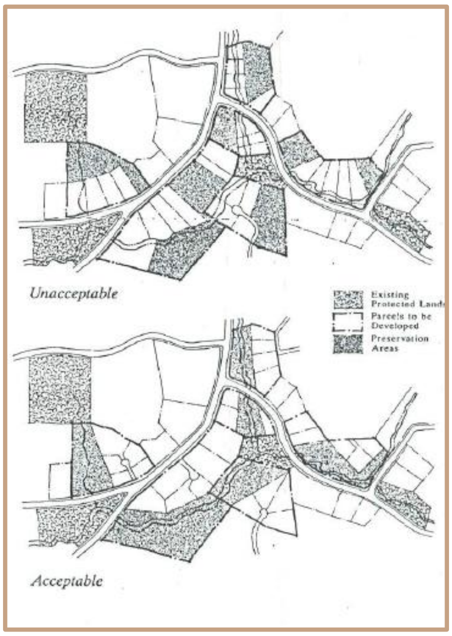

Figure 27: Large continuous integrated open space systems for conservation areas. Source: Randall G. Arendt, 1999.

Conservation subdivisions operate following a set of rules that recommend the best rules and configurations t for conservation areas: **Conservation areas should include the most sensitive Resource areas of a property, Fragmentation of conservation land should be minimized, and Conservation areas should be designated as part of larger continuous and integrated open space systems:**[48]

Once the data is gathered, conservation zoning techniques are proposed:

Most zoning regulations lack the necessary flexibility to promote design alternatives that incorporate significant open space, which could be appealing to landowners. Instead, zoning districts typically establish a minimum lot size and rarely require open space to be provided in new developments.

[48] Randall G. Arendt, (1999), Growing Greener: Putting Conservation into Local Plans and Ordinances, Washington DC: Island press,P 75-77.

Conservation zoning, on the other hand, provides landowners and developers with various density options that correspond to different open space set-aside requirements. The baseline density for land development is assumed to be 80,000 square feet per dwelling, with a basic requirement of 50% open space set-aside. However, a wider range of density enhancements may be available, depending on the percentage of protected open space set aside.

Multiple options for density are proposed, such as:[49]

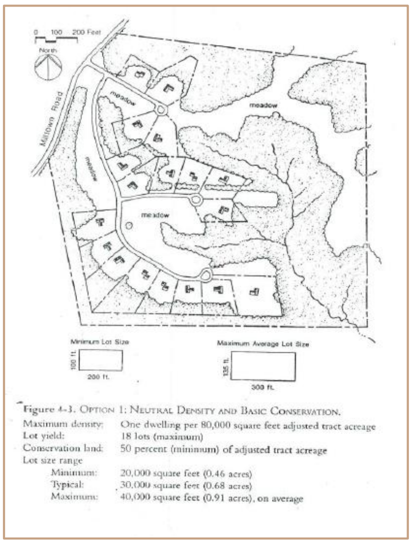

Figure 32: Neutral Density and Basic Conservation. Source: Randall G. Arendt, 1999.

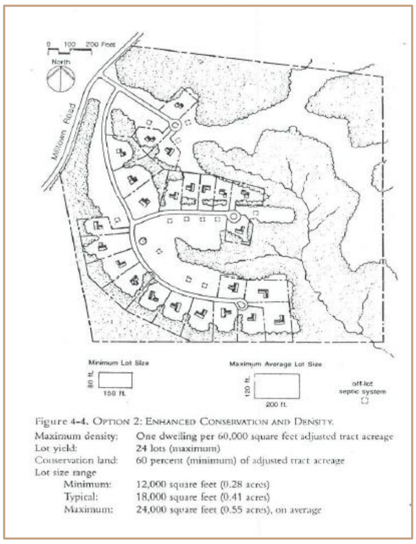

Figure 31: Enhance Conservation and Density. Source: Randall G. Arendt, 1999.

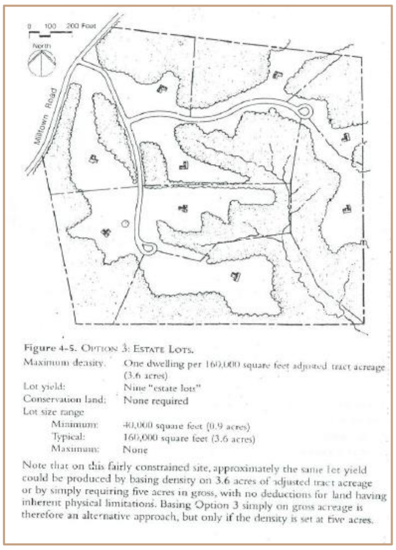

Figure 30Estate Lots. Source: Randall G. Arendt, 1999.

[49] Randall G. Arendt, (1999), Growing Greener: Putting Conservation into Local Plans and Ordinances, Washington DC: Island press, P 36-39.

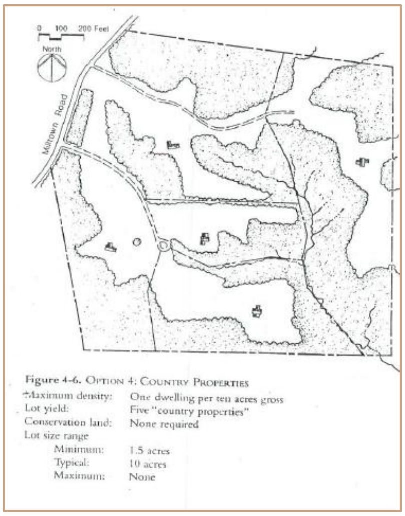

Figure 34: Country Properties. Source: Randall G. Arendt, 1999.

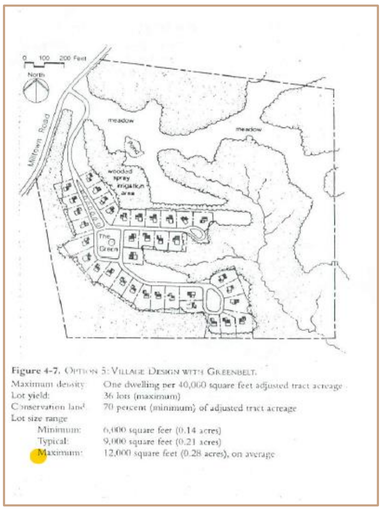

Figure 33: Village Design with Greenbelt. Source: Randall G. Arendt, 1999.

Technical factors:

Indications are provided on how and where individual septic systems can be installed, as well as subdivision recommendations to achieve better usage of soil: [50]

Figure 36: Disposal area located on better soils.Source: Randall G. Arendt, 1999.

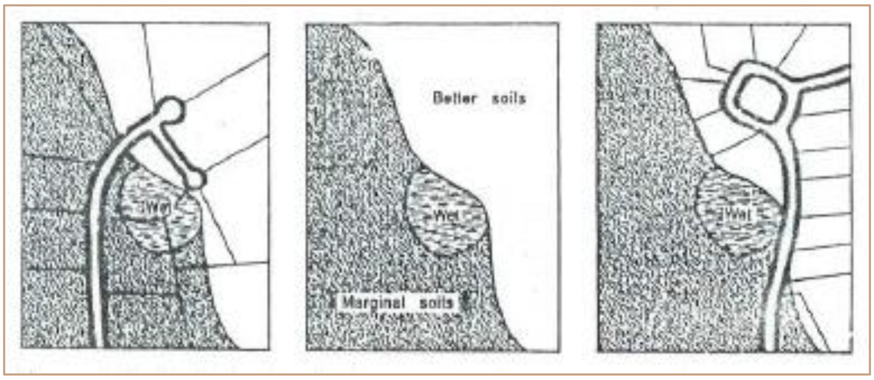

Figure 35: Lot size reduction advantage to locate home on better soils, making it easier to fit minimum legal requirements as well.

Benefits of the growing greener method:

There are quite a few benefits that can be cited when talking about the growing

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Randall G. Arendt, (1999), Growing Greener: Putting Conservation into Local Plans and Ordinances, Washington DC: Island press, P 46-47.

greener method, namely:

- **Environmental and ecological benefits**
- **Social and recreational benefits**
- **Economic benefits**

Environmental and ecological benefits:

- **Wildlife management**
- **Greater water quality protection**
- **Greater aquifer recharge**
- **Environmentally friendly sewage treatment and disposal**

Social and recreational benefits :

- **Pedestrian-friendly neighborhoods**
- **Community activities**
- **Community-wide greenings and trails**
- **Communities with multiple conservation subdivisions**
- **Model for the midwest**

Economic benefits

- **Lower costs**
- **Marketing and sales advantage**
- **Value appreciation**
- **Reduce demand for new public parkland**
- **Smoother review**[51]

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[51] Randall G. Arendt, (1999), Growing Greener: Putting Conservation into Local Plans and Ordinances, Washington DC: Island press., P 79-80.

V. Case studies:

Analysis of projects responding to thematic requirements:

1. European Centre for Geological Education:

a. Introduction:


Figure 37: WXCA center perspective. Source: Internet.

The European Center for Geological Education by WXCA is a visionary architectural project that aims to create a hub for geological education and research in Europe. The project has been designed by the renowned architecture firm WXCA, and its innovative design and sustainability features have gained attention from architects, researchers, and the public. The project is set to become a landmark in the field of geological education, providing a modern and functional space for learning, research, and collaboration. The center serves as a focal point for geological education, providing state-of-the-art facilities for both students and professionals in the field. The aim of this research paper is to provide an in-depth analysis of the design and construction process of the European Center for Geological Education by WXCA, with a particular focus on the sustainability features and innovative design elements that make it stand out.

b. Situation:

Located in Chęciny, Poland, in the Swietokrzyskie Mountains, the location exposes it's uniquenesss through rocks that illustrate ove 560 million years of the history of earth, making it a unique spot and phenomenon for geologists on a European scale:

Situation within general area:

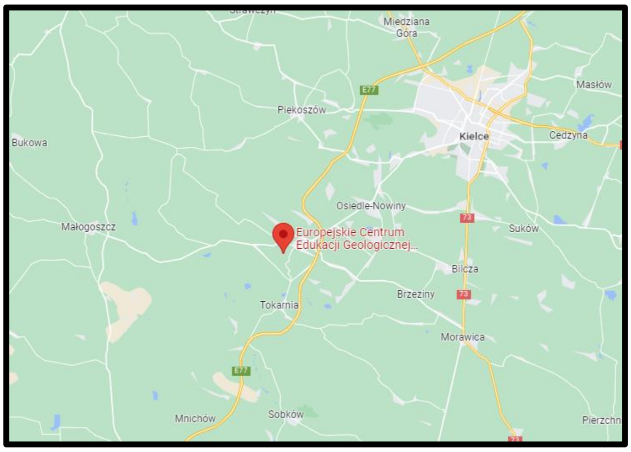


Figure 39: Situation within general area. Source: Google maps

Situation within country:

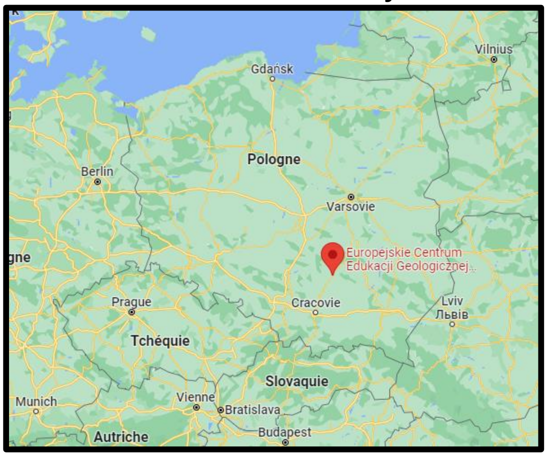


Figure 38: Situation within country, Source: Google maps.

c. Concept:

Regarding the history of the place as an ancient stone quarry, it was only intuitive to have scattered rectangular blocks of buildings like stone that was freshly cut, as well as to create a connection between what has been made by man, and made by nature, playing off as a reminder of the importance of managing natural resources, the goal of the project was to complement the unique location through form, and not dominate it.

d. Program:

Five buildings compose the complex, A main block houses representative functions such as the lobby and foyer, as well as a large auditorium hall, A second block contains laboratories and acts as a research facility, it is where the process of pre-treatment, formulation and analysis acting as a technological line happens, all happening next to an educational area that enables young geology students to join the process

Figure 40: Roof view. Source: Internet.

The remaining three structures serve as the hotel premises, with Building 3 designed to a superior standard for the convenience of the facility's staff and guests, while Building 4 is designated as a lodging base for students.

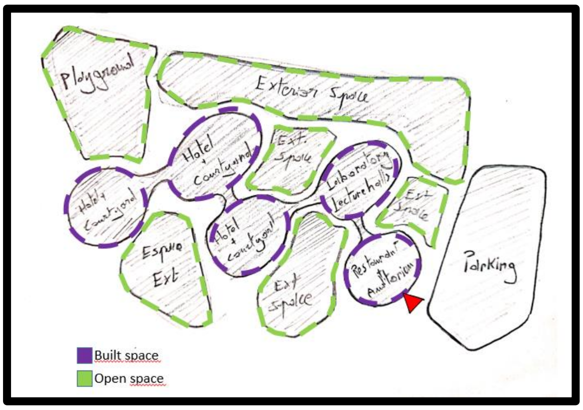


Figure 41: Program layout. Source: Author.

The hotel buildings feature double rooms, each of which boasts a generously sized window and a spacious desk that seamlessly blends with the window. This innovative design enables guests to enjoy serene moments of studying or admiring the picturesque landscape.

e. <u>renewable energy:</u>

Figure 42: View of project within context. Source: Internet.

The buildings in this project primarily rely on heat pumps with a ground heat exchanger for their heating and cooling needs. To achieve this, a network of 91 wells was drilled to a depth of 120 meters to extract heat from the ground. The heat pumps operate via a "water" / "glycol" system.

To supplement the heating, a solar installation featuring solar collectors on the roofs is also utilized to heat water.

Furthermore, the landscape design and green roofs incorporated into the project are designed to preserve the natural plant species indigenous to the area, including grassland swards.

2. Svalbard Science Center:

a. Introduction:

The Svalbard Science Center is the extension of an existing building at the University of Svalbard. It was inaugurated in April 2006.

With 8,500 square meters to the current 550 (which have been restored), is the largest building in the Svalbard archipelago.

Figure 43: Exterior project image. Source: Internet

Raise buildings Svalbard has additional climate-related challenges.

The manufacturer claims that the first was the transport of materials. The port of Svalbard is frozen from January to May and construction started in March. The conditions were like in the mainland where you can search for materials and equipment when needed, everything has to be planned, down to the smallest detail, but the planned planning breaks down.

The first load was transferred to Mars under a meter-thick layer of ice and required a Norwegian Coast Guard vessel, which drove through the ice blocks on the harbour.

These climatic challenges explain why the use of prefabricated elements had to be minimal.

b. Situation:

It is located in Longyearbyen, capital of the main island of Spitsbergen, in the Svalbard archipelago in Norway.

Immediate Situation:

Figure 44: Project Immediate situation. source: Google maps.

Situation within country:

Figure 45: Project situation within country. Source: Google maps

c. Concept:

The design of the building is inspired by the five-pointed stars that come out of a central core, fully responding to an extensive climatic analysis of the place.

This geometry and its copper skin cover reference the landscape, adapting to the movements of the wind and the snow.

To study the architects Jarmund / Vigsnes, who won the project through a narrow competition, there were several elements to consider in the design of the work.

First of all, it was important to create a building that is integrated into the landscape, obviously for aesthetic reasons, but it was also necessary to measure as accurately as possible, thanks to state-of-the-art technology, the speed of the winds and movements of snow masses, to design a building that does not stop the snow, that does not interfere with their adoption, and to avoid their accumulation in extreme glaciers while building around the building.

Second was to protect the environment. Like all buildings on Svalbard, New Science is built on piles sunk into the permafrost, erected to prevent icing.

d. Spaces:

Besides the University, will host the Museum of Svalbard, the Polar Science Institute, the administrative offices of the authorities of the center of the island, a library and cultural.

The complex construction set makes each character distinguish the different parts.

In public areas, the design and installation of roof panels refer

To "extract" traditional occupation of Svalbard. Pine panels are mounted cupolas that seem so carved into the rock.

The slope of the walls accentuates the “cellar” effect. In contrast architects and reflect natural light have chosen to give the doors and their frames, bright colors: green, orange and red.

To highlight the different dynamics in the rooms, the architects played with window placement and different ceiling heights.

e. Structure:

In the structure was used steel and wood.

In the main building, we have chosen to use wood to facilitate the adaptation and work of the structural loads on the ground and to avoid thermal bridges. The glued laminated timber reaches 26 meters in length.

The variety of forms that exist in the construction of the walls and the ceiling gives a unique character to work. Sometimes the two are united in a vault, with a detail to keep in mind that inside the building there is no angle or straight wall and the ceiling is made up of 34 different surfaces in planes different.

f. Materials:

Wood is the predominant material throughout this work.

The ceiling and the walls are covered with pine wood and the parquet is in ash wood. We used the first 40,000 square meters and 4,000 the second.

The wood of the walls are covered with transparent varnish and the floor with oil.

According to the architects, wood was chosen for several reasons, including creating a warm ambience inside the building, but nothing can compare to a refuge from the cold and darkness, from late October to mid-February, the sun peaks over the Svalbard archipelago and its inhabitants air, inside the buildings, a contrast with the 15 degrees below zero outside.

The only materials used were prefabricated horizontal divisions between the plants.

g. **Insulation:**

Given the extreme contrasts between indoor and outdoor temperatures, as well as the use of wood in the main structure, the exterior insulation is made up of two layers of welded copper membrane, breathing and allowing moisture to escape.

The outer fabric strips is fixed by special screws and nuts mounted against the neoprene membrane.

Inside insulation was used without open joints. It is an auto membrane asphalt fixer with an aluminum core in case of drilling nut effect.

h. **Environmental:**

The work is a new benchmark for the construction of buildings of this size in such latitudes, at 78 degrees, in a fragile natural environment whose conservation is of general interest.

Given the size of the building, which is several times that of current Svalbard, the environmental issues were much greater and the construction process and the materials chosen had to adapt to very strict criteria.

3. **Sheikh Zayed Learning Center:**

a. **Introduction:**

A development project for the Al Ain Wildlife Park & Resort in the UAE involves several components, such as the renovation of the Al Ain Zoo to include a safari zone for observing local wildlife and the creation of a tourist resort and residential spaces. The Sheikh Zayed Desert Learning Center is part of this project and serves as an exhibition center that showcases research in the field of natural and cultural history of the Arabian Desert and other deserts worldwide.

Figure 46: Sheikh Zayed Desert Learning center project overview, Source : internet

a. **Situation:**

Immediate Situation | **Situation Within country:**

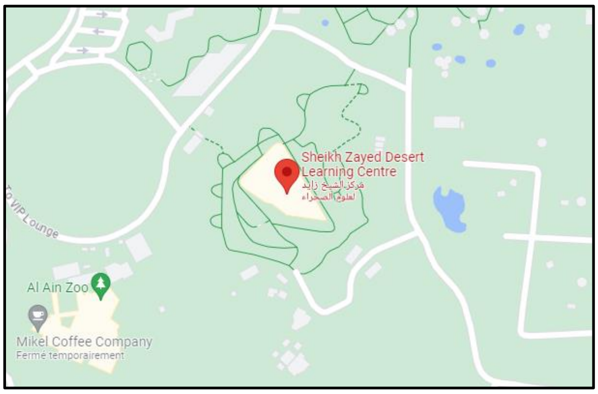


Figure 48: Sheikh Zayed Desert Learning Center Immediate Situation. Source: Google maps.

Figure 47: Sheikh Zayed Desert Learning Center Situation within country. Source: Google maps.

b. Sustainability:

A key issue in hot climates is how to cool buildings; as a rule this consumes a great deal of energy. The Desert Learning Center reveals how the architectural design can help to keep down energy consumption for cooling.

The building lies partially submerged into the ground to some extent – one-third of its cubic content lies below ground level. The entrance area faces north. A low heat transfer coefficient, coupled with the considerable thermal mass of the outer shell (made up of massive concrete walls with an insulated sandstone façade plus air gap behind) greatly reduces the amount of energy needed to cool the building. A roofed enclosed courtyard and a shaded outside court also help to benefit the building's climate.

The deep window recesses and roof overhangs above the large glass façades minimize the amount of direct sunlight entering. But enough daylight is still emitted into the building to illuminate the interior efficiently, in conjunction with the building's pioneering approach to lighting.

c. Energy:

The Sheikh Zayed Desert Learning Center is an almost self-sufficient building that, thanks to solar thermal, geothermal cooling and photovoltaics, can provide 80% of the base load almost continuously with renewable energies. Through the sensible combination of active and passive use of solar energy and the use of water and energy-saving systems, the building was able to meet the highest sustainability criteria.

The building was certified with the LEED™ Platinum Standard by the American program LEED™ (Leadership in Energy and Environmental Design) and was the first building in the Emirates to be awarded the Arabic green building seal of approval ESTIDAMA 5 pearls.

Synthesis:

The first project's most interesting feature lies in the Program configuration, as it is laid out in a way that allows for constant exposure to the outside, further reinforcing the context and serving as a reminder of the project's location and how well it is integrated within it, This constant exposure to the outside is also a very positive element for the physical and mental wellbeing of the center's occupants, contributing in their productivity.

The connection between interior and exterior, and between the different parts of the project is also very present within the individual units as there is no transition space, each unit is directly attached to a single line that links all the different areas together, while this might be the simplest way to provide path readability, it remains an interesting prospect when elaborating our project.

Lastly the proximity to open spaces is also an advantage of this project, as each singular unit is directly facing a green open space, once again one of the simplest modes of introducing natural surfaces to a project, in our case by juxtaposition, but a very strong point of this example.

The second example carries additional insight in terms of environmental implementation through materiality, the inclusion of local wood within the interior for structural and comfort reasons is a necessary approach in arid environments where the only resources accessible are local.

The third project serves as a very effective example in terms of elaborating materiality and implantation within a context similar to the Saharan environment, The combination of Stone as a thermal insulation tool directly superposing the base concrete walls, as well as burying parts of the project for thermal regulation, offers a few very necessary guidelines on how a project should react through the parameters of materials and implantation to a desert-like environment, providing maximum comfort in terms of temperature and reducing energy consumption.

CHAPTER 3

1. Introduction to the context : city of BOUSAADA

Bou Saada (Arabic: بو سعادة, bu s‘adah, meaning "place of happiness)

Figure 49: Situation of Bousaada on Algeria's map Source: Wikipedia.

Bou-Saada distant from the capital of the wilaya of M'sila 75km to the south, it radiates throughout the southern part of the territory of El-Hodna. It is also the city, through which transit the local populations, it represents the social link between two tribes (El-Hodna - Ouled Naiel) having for natural limit "Essabkha", going from Baniou to El Maarif (Yousef NACIB, 1986). The city of Bou-Saada is in fact an attractive center in tandem with M'sila, a strategic role which gives each a particular economic and social influence.

Bou-Saada is located in the southwest of the Hodna region in the Hauts Plateaux, at the feet of the Ouled Naïl Range of the Saharan Atlas. Because of its strategic location, it is given the synonym of "gateway to the desert", since it is the first oasis encountered when heading to the south from Algiers.

Bou-Saada has traditionally been an important market place producing and selling jewelry, metalwork, carpets and bousaadi knives. There is also a textile mill in town. Even in modern times, Bou-Saada is an important trading post for nomads. There is also some national tourism during winter. Bou-Saada is well-connected with other urban centres by road. M'Sila is 70 km northeast, Biskra is 175 km east, Bordj Bou Arreridj 130 km northeast and Djelfa 120 km southwest. Bou-Saada has two quarters, the old medina (ksar) within the city walls with arched alleyways, and the French town to the south. Surrounding the town are extensive date groves.

a. Geographic context

On the administrative level, Bou-Saada was promulgated in 1974 with the rank of chief town of daïra at the same time as M'sila as chief town of wilaya, it includes two communes El-Hamel and Oultem. Its total area is 255 km². It is limited by :

Figure 50: The administrative situation of the municipality of Bou-Saada .Source: B. NOUIBAT, 2007.

- In the North, by the municipality of Ouled Sidi Brahim
- To the North-East, by the municipality of Maarif.
- To the east, by the commune of EI-Houamed.
- To the West, by the municipality of Temsa.
- To the south-east, by the town of Oultem.
- To the southwest by the municipality of El-Hamel.

b. History:

The city of Bou-Saada not only represents an integral part of the region, but a link between the sea and the desert, agriculture and pastoralism, sedentary lifestyle and transhumance, which is why it was already populated in long dates (Yousef NACIB, 1986). Its medina is the first core of the city which remains until today, it is represented by the Ksar which was founded in the 13th century on the highest point of the eminence. Its location near the wadi makes it a naturally defensive site.

The medina had retained its charm until the day after independence. It has seen a great tourist boom which has given way to an accelerated development dynamism, due to its position as a crossroads for all directions. This dynamism jeopardizes the priceless historical heritage of this medina, it generates an urban and architectural framework that continues to deteriorate.

Bou-Saada in its configuration, therefore, is the result of a historical process. Its distribution of urban space is a question that is both current and crucial, such as the future of the medina, if it continues to undergo chaotic private construction on the fringes of an urban master plan.

“Today the medina has changed considerably on several levels, due to the urban development of the entire city. Its palm grove has become very limited. Sociological and cultural changes also appear with the geographical displacement of residences. The population of the ksar who opts for the modern city must get rid of ancestral patterns and behaviors in favor of new ones” (Yousef NACIB, 1986)

c. Climate:

	Jan.	Feb.	Mar.	Apr.	May.	June	Jul.	Aug	Sept.	Oct.	Nov.	Dec.
Min	3.7	5.6	7.0	9.9	13.1	17.5	21.1	20.0	17.3	11.9	9.3	4.2
Max	13.2	16.1	18.4	22.6	27.6	32.4	37.1	35.5	29.9	22.9	16.9	13.7

Figure 51: Monthly temperatures in bousaada. Source: Youcef Nacib, 1986.

Bou-Saada belongs to a semi-arid zone, between temperate and tropical climates, characterized by a drought that is always a concern for the people who live there, sedentary or nomadic. And yet the luck of Bou-Saada is precisely due to its geographical position, it is this which will determine the whole history of the city (Yousef NACIB, 1986). Its climate, therefore, is characterized by winter, spring and autumn rainfall, rare and irregular. Its site appears as a west-northwest to east-southeast oriented corridor, so only rain disturbances arriving from the west or northwest are likely to fully reach it.

d. Temperature and wind:

The wind is one of the essential features of the climate of the entire Bou-Saada region, the situation of an open basin facilitates the penetration of winds coming from all horizons through the inter-mountain corridors, this basin also experiences the strongest winds of the country. The city of Bou-Saada receives, during the winter, the winds from the cold and dry North-East, and in summer, from the South-West, a hot and suffocating wind, which sometimes blows for whole weeks, with extreme violence, for four months during summer, Bou-Saada is like in an oven and the thermometer stays there between 40 and 42 degrees.

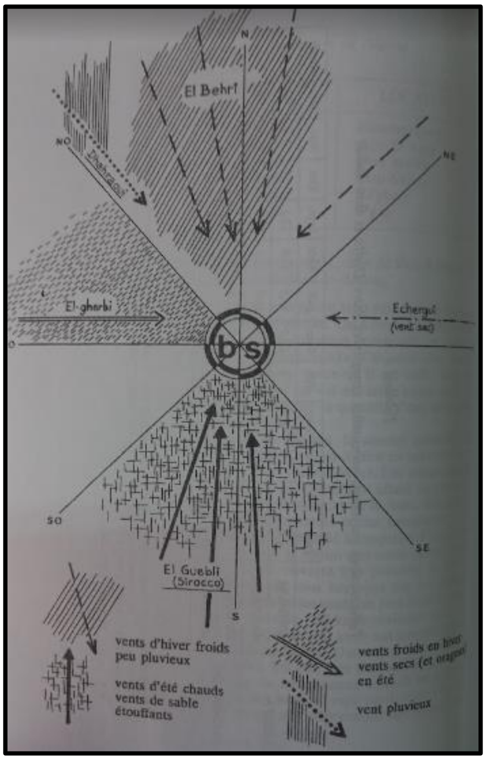


Figure 52: Chart of different winds in Bousaada. Source : Youcef Nacib, 1986.

"The rain gauge shows only an average of 250 coincides in time with the lowest rainfall 6mm/month July. The heaviest rainfall is in January and April more than 30mm / month. Stormy rains can cause flooding or flooding of the impressive Bou-Saada wadi. The river then carries trunks of uprooted trees or formidable blocks of stone for the camps of the inhabitants installed near the banks" (Y. NACIB, 1986).

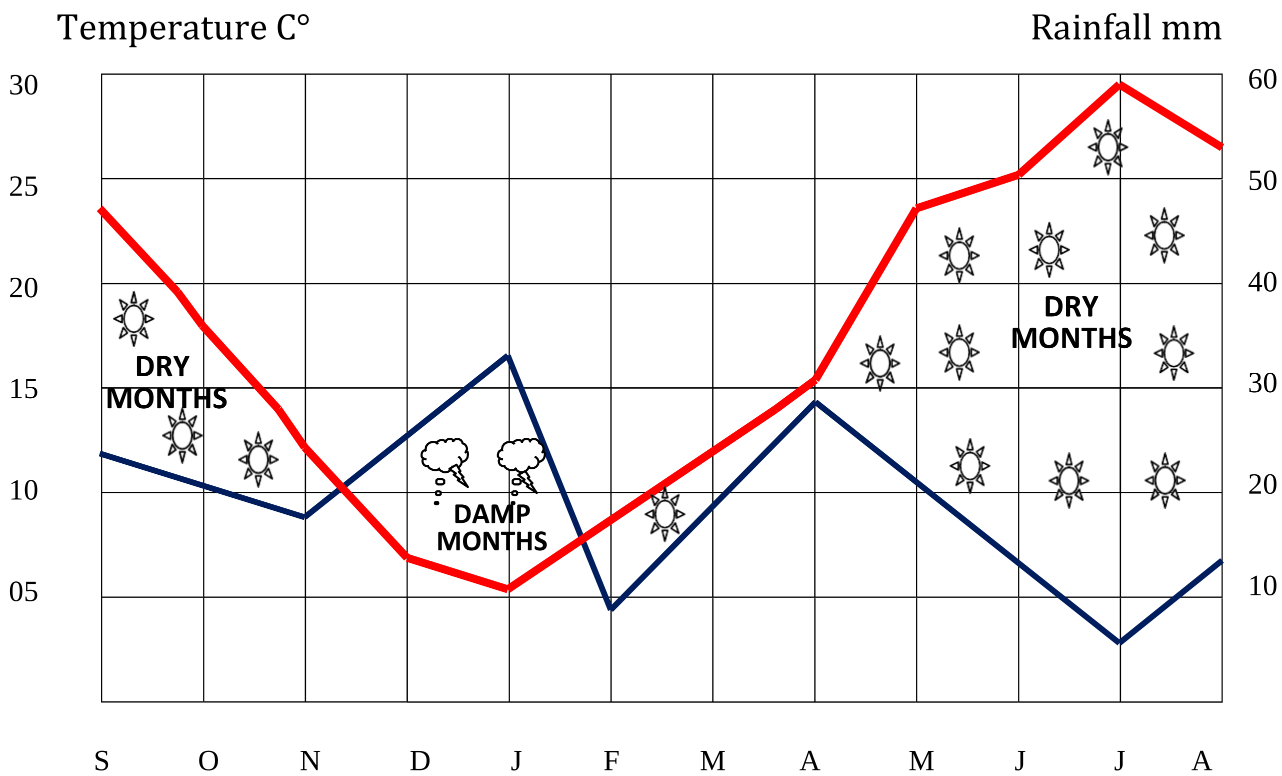


Figure 53: ombra-thermal curves, Bou-Saada,Source : (Yousef NACIB, 1986).

e. Topography:

Bousaada's topography is one of the main factors that have contributed in confining the city, as its morphology is a direct result of the natural borders create by Djbel Kerdada at the south, and al aouidja at the west.
The city seems to have followed a patten alongside Bousaada's Oued , which runs parallel and next to Djbel kerdada.

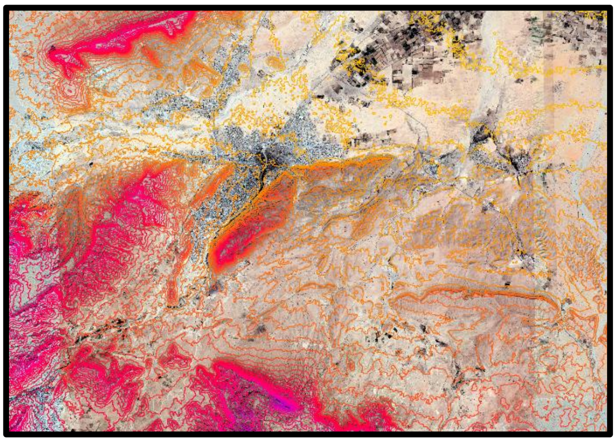
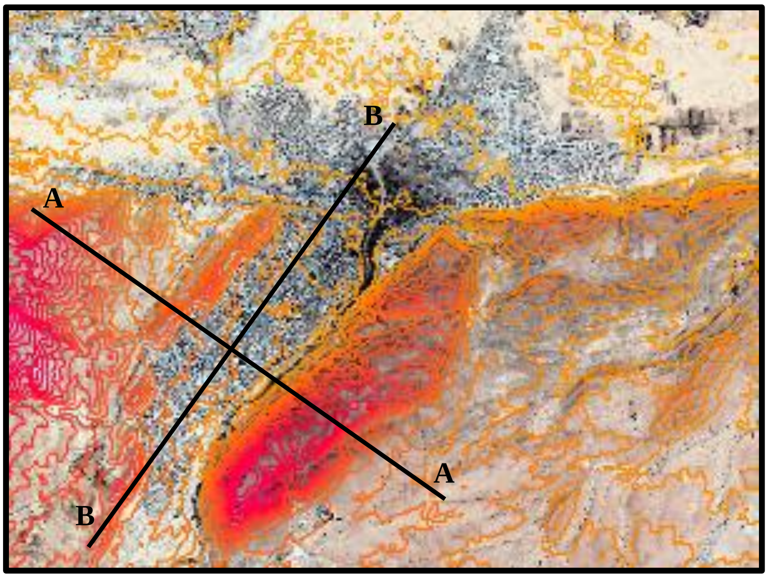


Figure 54: Bousaada's topography delineation map. Source: Authors

These conditions not only present themselves as natural barriers for bousaada's city growth, limiting the options for it to spread

only within the confines of a relatively narrow corridor, but also as protective features which serve as shields against winds coming in bousaada's direction.
The city's topography is not completely flat, as heights seem to vary, a clear slope can be observed parallel to djbel Kerdada and djbel al Aouidja which also dictates the flow of water for Oued Bousaada from North-East to South-West.



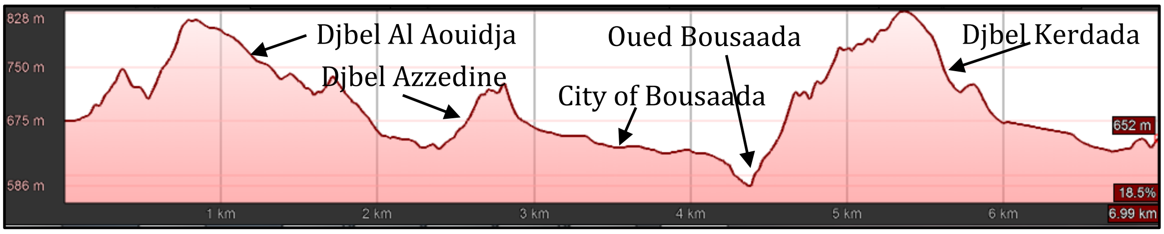


Figure 56: A-A' section. Source: Authors

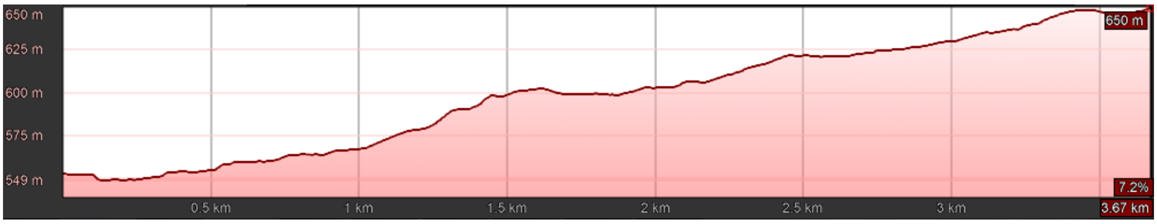


Figure 55: B-B' Section. Source: Authors

f. Diachronic analysis:

Introduction:

Bousaada, nestled in Algeria, showcases a rich history and unique culture. Analyzing its chronology uncovers its transformation from foundation till now. Exploring historical periods, urban changes, socio-economic shifts, and cultural evolution unveils Bousaada's significance and tapestry

Process of historical evolution:

Foundation and first establishments:

Bousaada's history starts with its founding and initial inhabitants. Berber communities inhabited it, followed by Arab tribes, influencing its culture. The founding era shaped Bousaada's identity and set the groundwork for its development.

Construction of the ksar:

In the Middle Ages, Bou-Saada emerged in the 13th century under the guidance of "Sidi Thameur" and "Sidi Slimane." They built the "Djamaa El-Atik" mosque, distinct from other Algerian mosques. Over the Ottoman regency, Bou-Saada's medina expanded, organized around the "Sidi Thamer" mosque and neighboring districts like Ouled Hmaida and El Mouamine. The resulting medina displayed a spontaneous, intricate layout.

Colonial era:

French colonization brought significant changes to Bou-Saada, with urban planning and infrastructure development. European architectural styles blended with Algerian elements, impacting not just the city's physicality but also introducing new ideas, languages, and societal structures. The colonial period created a separation between the traditional medina and the colonial district.

Post-independence:

Independence marked a turning point for Bousaada. Reconstruction efforts aimed to reclaim cultural heritage and strengthen local identity. Infrastructure projects focused on socio-economic development, revitalizing the city. Population densification and unsuitable expansion impacted the medina's built environment, leading to degradation. Operations were carried out to address this, altering the city's architectural configuration.

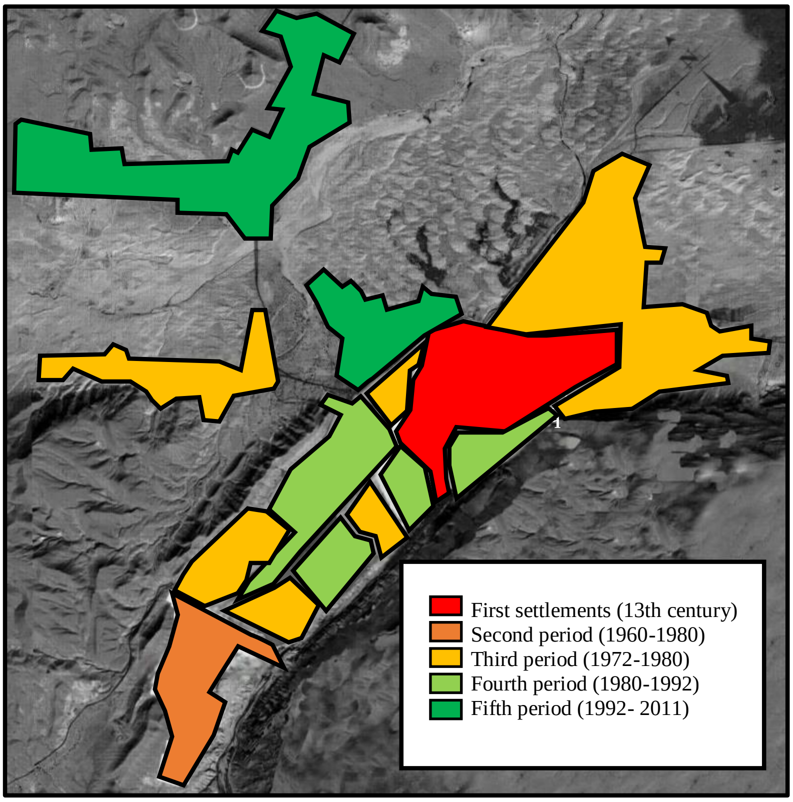


Figure 58: Synthetic map for the evolution of the city of Bousaada. Source: Authors.

Summary:

Boussaâda's analysis reveals a journey of growth, resilience, and cultural preservation. From modest beginnings to a vibrant city, it has evolved based on historical strengths and aspirations. The urban transformation showcases extensions, modernizations, and new districts. Maps, aerial photos, and urban plans document the physical changes shaping Boussaâda.

2) Intervention: Theoretical Part :

This part will discuss the execution of the aforementioned theoretical part, the case study being BOUSAADA, it will be split into two parts, the first being a global intervention performed at the scale of Bousaada's main city and its surroundings, which will be followed by a second intervention at a smaller scale, more specifically Bousaada's Oasis.

1) SUITABILITY STUDY:

Similar to Ian.Mcharg's proposed intervention which involves the creation of a value system in the form of maps, notably the social and engineering value maps, a similar operation is proposed in Bousaada.

The Initial aim is to create a framework interpreting the general lines that go into initiating a value system that can be taken into account when operating on Bousaada specifically.

To do so, Each of the aforementioned examples has had their parameters extracted, deconstructed, crossed, filtered, and then categorized, giving us a general idea of the maps necessary and the different categories that they fit into, the last iteration formatting has been as such:

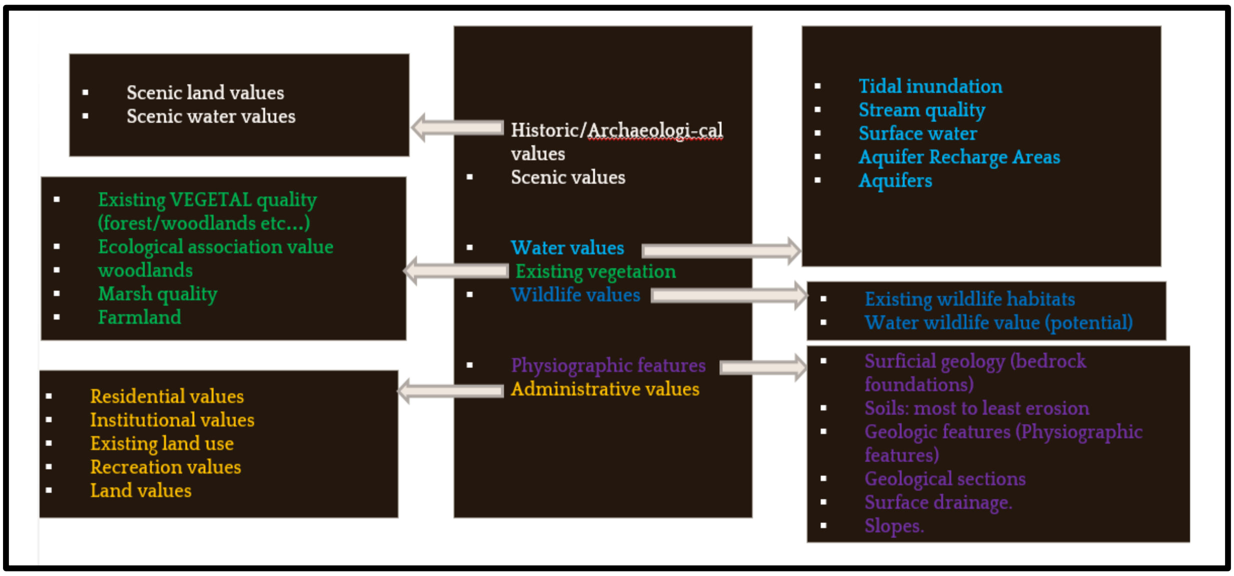


Figure 59: General chart of Methodology resources. Source: Authors

The chart above represents the initial framework of data collection that has been used as reference, it has been established following specific guidelines:

- The framework can ONLY contain Data that is part of Ian.Mcharg's performed layering analysis.
- When consulting different examples, elements that overlap or that fall in a general category or seem as though they are part of the same criteria are combined into a single map.
- Only maps that are considered absolutely necessary are considered as top priority for data acquisition, the goal being to reduce the probability of being unable to find certain types of data while making sure there are enough maps of different categories to make sure parameters are considered across the board.
- Only maps that are compatible with the study area are considered, since the context is vastly different, map priority changes, the unique climate of Bousaada, which encompasses both the desert and plains means that certain features are more prominent in terms of importance, such as aquifers or agricultural land or vegetation in general, since they are the highest ranking in terms of importance in such climate as well as in terms of scarcity.
- Another important part of the study is identifying which parameters are important for defining certain suitability maps, notably: Conservation,

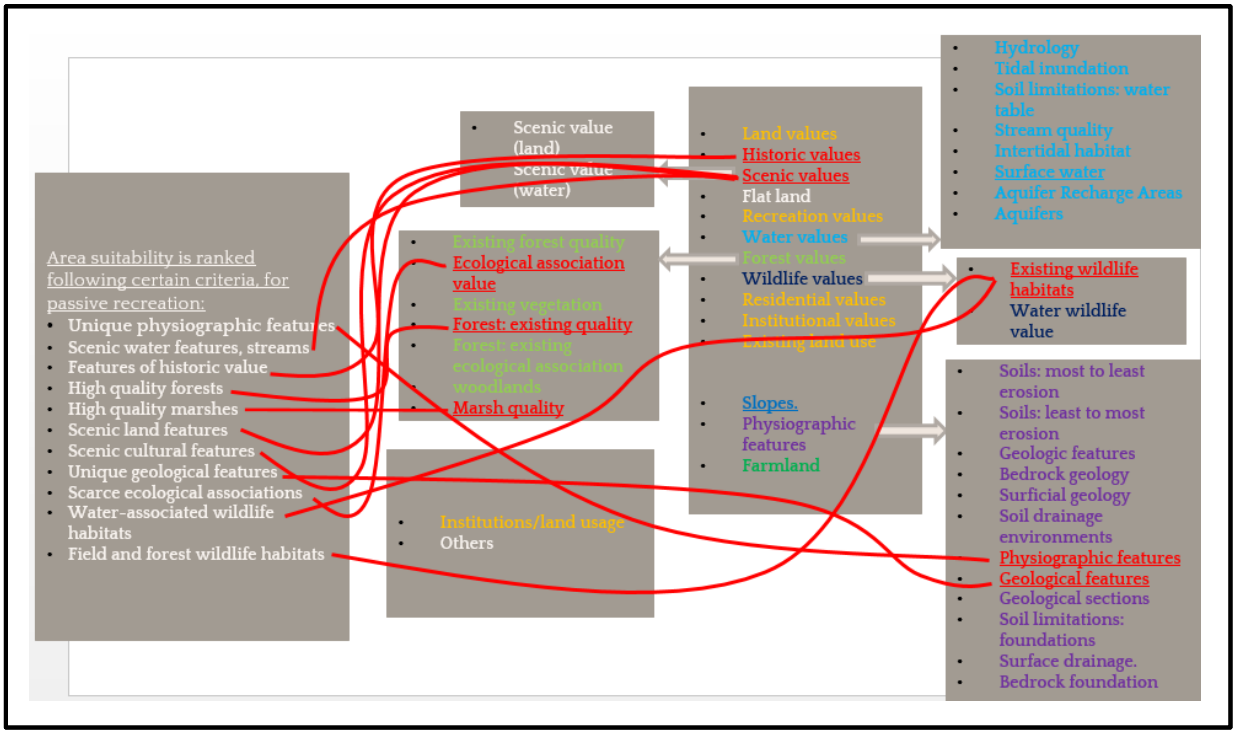


Figure 60: Compatibility chart for passive recreation. Source: Authors

Residential, Commercial Industrial, Passive and active recreation, and unsuitability for urbanization maps, the goal being to keep the most necessary parameters to produce the aforementioned maps

Once the general lineup of categories has been established, the more detailed range of parameters to include is created, each map falls under a specific category and branches out into a rank system of three values, following Ian.Mcharg's initial proposition, this allows us to evaluate every single value map with three value ranks, which means that each map has it's elements divided into three different values: most valuable, of medium value and of low value, with each map having it's distinct rank categories, for example slopes has its highest value element being the lowest slope percentage, and it's lowest value element being steep slopes, Aquifers are ranked the highest when it comes to major ones, but lowest value when it comes to urbanized or polluted aquifers.

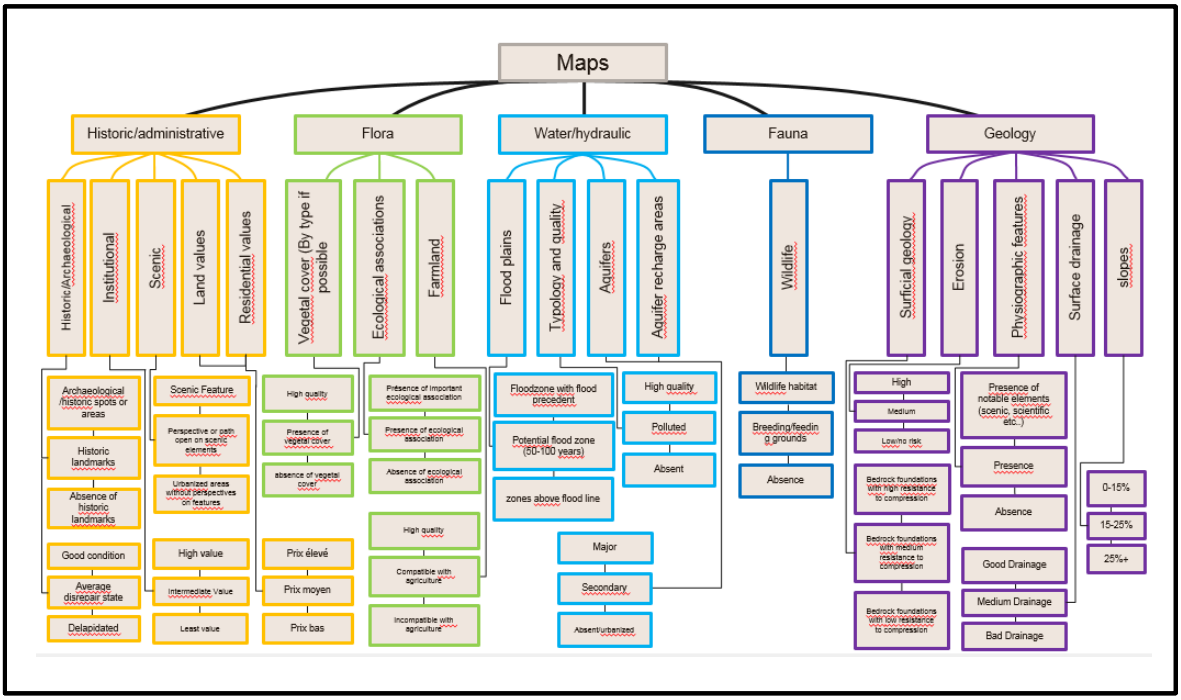


Figure 61: Mental map of all features considered. Source: Authors.

This layout allows us to visualize what we exactly need from each parameter and to have a better understanding of how to interpret elements of a map into different values.

Following the more detailed definition of elements, a reassessment is made, to redefine what parameters go into making the different suitability maps.

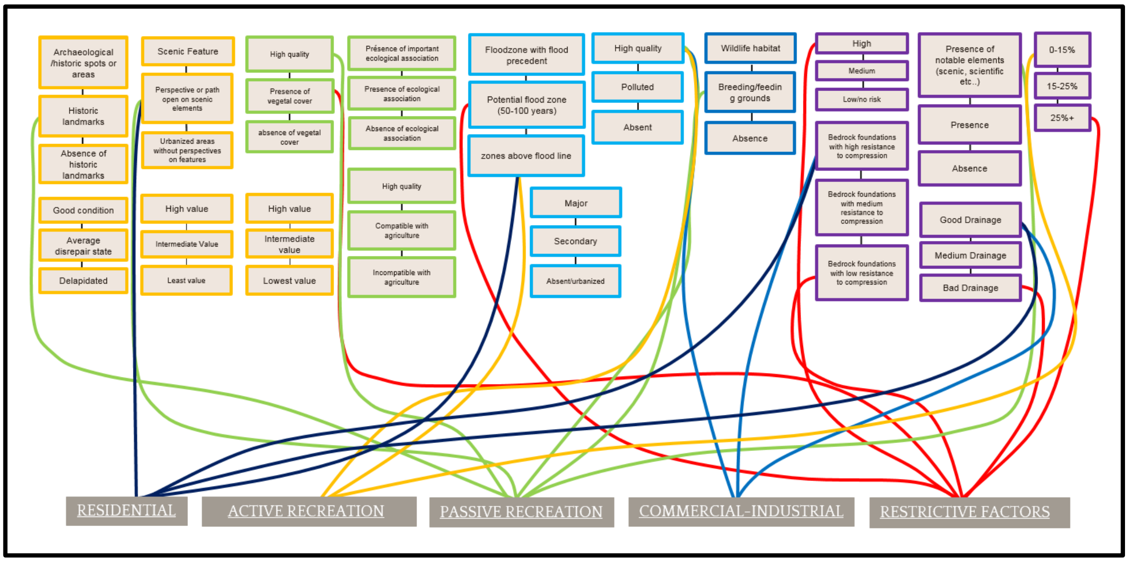


Figure 62: Mental map for land use compatibility based on predetermined factors. Source: Authors

Next comes the formatting for data collection operation, with a now visible framework the priority becomes to acquire said maps, the mode of operation suggested is similar to what is proposed by Ian.Mcharg and Randall G. Arendt:

- **HISTORIC MAPS:** are there any noteworthy elements of the city that would be considered HISTORIC, representative of culture/historical event and/or have touristic value, please note that details of their current state is also needed (how preserved/deteriorated they are)
- **ARCHAEOLOGICAL:** are there any areas that exhibit Archaeological potential, for either scientific or touristic (museum?) purposes?
- **SCENIC VALUES:** drive around in a car in company of a local bousaadi, ask for the routes with the best views (ex: moulain ferrero), take notes of viewsheds and areas from where certain physiographic or scenic elements are visible (not ANY element is considered scenic but in most cases we are looking for prominent natural elements, and secondly scarcity of scenic elements).
- **ADMINSTRATIVE VALUES:** for LAND/RESIDENTIAL values, a pre-existing map, made by local real estate agencies or other local respective services to have an estimate of monetary value of land and dwellings per m2, for the Recreation/insitution and exsisting land use values, tools like PDAU can be consulted to gauge importance of Insitutions/Recreational areas IF

demolition/other means of improving functionality and usage are deemed necessary.

- **VEGETAL COVERAGE:** vegetation for all 3 categories (woodlands, marshes and forests) and any subcategory (arid lands with punctual vegetation) has to be classified into 3 distinct categories, the first being prime quality of all of the above, then degraded/low quality (depending on certain criteria like plant health etc…) and third is areas with next to none of the aformentioned plant categories. **NB: IF THERE ARE ANY EXISTING CATEGORIES THEY SHALL BE INCLUDED ASWELL, ex: medicinal plants, rare or scientifically valued species, threatened species etc…**
- **ECOLOGICAL ASSOCIATION VALUES:** Which designates areas where more than one plant species reside on the basis of mutally benefitial relationships/tolerances and not simple juxtaposition.
- **FARMLAND:** Should be ranked as such: PRIME agricultural land, potential for agriculture but currently degraded/ requires work/investment and land that is incompatible with agriculture.
- **TIDAL INUNDATION:** represented as buffer zones around areas that are prone to inundation, like rivers and streams, required data in terms of percentages (2% for 50 year floodplain and 1% for 100 year floodplain)
- **STREAM QUALITY:** ranking stream quality and cleanliness to determine potential usage, if clean water then aquaculture can be considered etc…
- **SURFACE WATER, AQUIFER RECHARGE AND AQUIFERS:**
  Surface and underground water both get categorized in terms of importance (major/minor etc…) with the type mentioned (lake, stream, pond etc…) in terms of surface water, since the zone is of arid nature and the major inconsistency can be the water abundance/flow itself, can also possibly be categorized in terms of frequency
- **WILDLIFE VALUES:** rather simply enough, wildlife habitat and breeding/feeding grounds should be roughly delineate on our map to represent conservation boundary, as for WATER wildlife, because of the arid context once again we only consider potential areas for water wildlife breeding activities (aquaculture)
- **SURFICIAL GEOLOGY:** a map should be produced ranking 3 different levels of

bedrock foundations, high compression resistance bedrock, medium, and low resistance.

- **EROSION:** Similarly, a map of general areas at high risk of erosion, more erosion-stable areas and lastly areas that are not prone to erosion.
- **GEOLOGIC FEATURES;** these include any kind of physiographic element of the land, mountains, rivers, lakes etc…dry rivers which there is an abundance of (potentially also sand dunes).
- **SURFACE DRAINAGE:** areas with certain specific properties such as water table being at a certain level and the ground having a certain porous quality, intended for drainage systems.

3) Intervention: Practical Part:

a. Production of maps

The next step consists of producing the maps, which has been done through various means, including the use of ESRI satellite maps, and drawing maps on-site with the help of experts and local officials.

Historic Values:

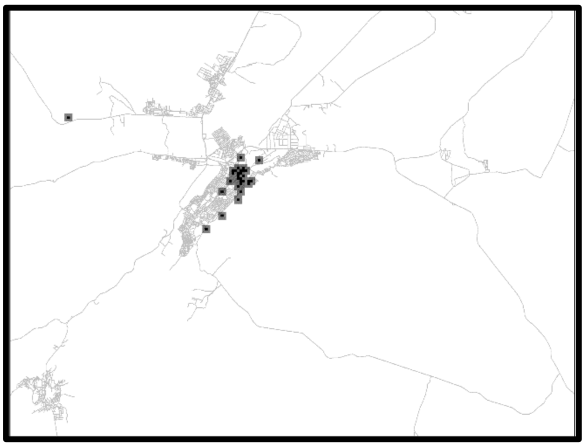


Figure 63: Historic Values. Source: Authors.

Prominent city landmarks and their close proximity were identified with the help of a local expert **(SAID HABICHE)**, as well as their estimated state (good condition, partially deraded, completely degraded).

Scenic Values:

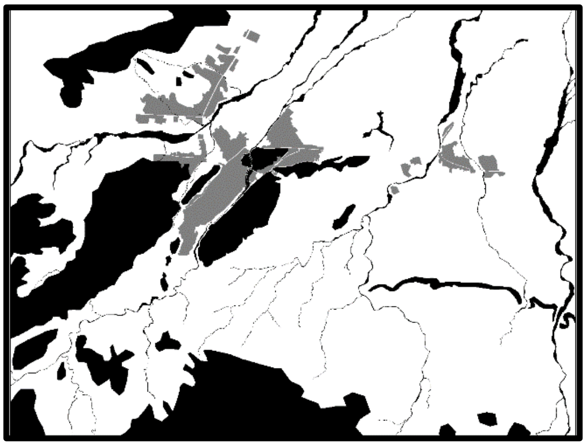


Figure 64; Scenic values. Source: Authors.

Scenic features as well as urbanized areas with no prominent viewshed have been identified, the remaining areas represent open viewsheds with perspectives on the scenic features.

Administrative Values (social values):

Figure 66: Social values. source: Authors.

Administrative values have been identified according to existing land values (potential price of land per m2 and price of residences) with the help of the mayor of Bousaada to formulate a map with the highest potential land value in the future, as well as secondary and tertiary consideration for further land development.

Vegetal Coverage

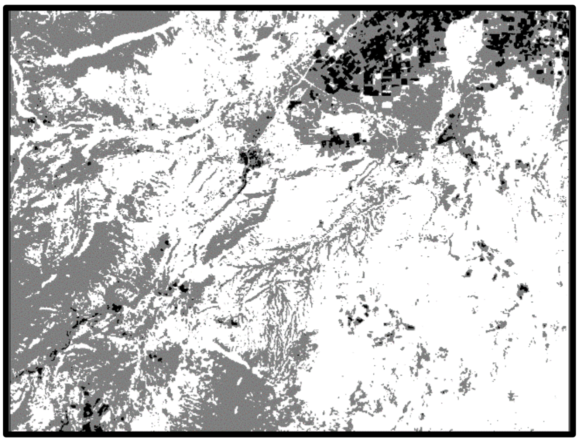


Figure 65: Vegetal density. source: Authors.

Because of the lack of data that specifies the condition of local fauna or flora, our next obvious indicator is represented by vegetal coverage density, as more dense vegetation also indicates better health for the existing flora

Ecological association Values:

Identifying individual species has proved being quite difficult, as inventories for local vegetal components exist but cartography (botanic maps for example) seem to be absent, older studies of the vegetal cover and composition of the area (Chott el Hodna) are present and available but deemed to be too old be able to be used in our study, in addition to the fact that they would still need interpretation by experts to classify the degree of importance of the species.

Farmland (Vegetal Type):

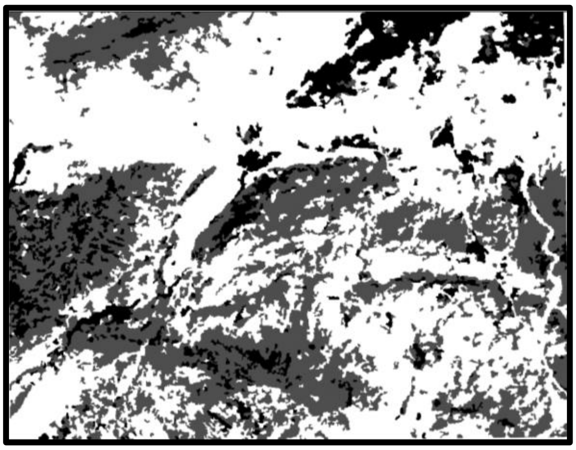


Figure 68: Vegetal type. Source: Authors.

Tidal Inundation (Proximity to streams):

Figure 67. Tidal inunation. Source: Authors

Satellite data (African living atlas) has been able to provide us with an accurate categorization of vegetal typology, the most important being agricultural, followed by grassland and other lower density vegetation which are considered valuable for grazing, and lastly barren land and minimal vegetation

Tidal inundation has been estimated to start from the streams themselves covering a relative proximity for immediate flood, the next area seems to be the most compatible with urbanization as it decreases the distance from the closest water source and it follows the same pattern as Bousaada's old city centr and it's relative distance from the stream. The furthest distance ist he least considered due to its distance from any potential water source.

STREAM TYPOLOGY:

Figure 70: Stream typology. Source: Authors.

As an alternative map to surface water typology, seen as the only prominent surface water features within bousaada are streams, has been produced manually with combination of satellite imagery as reference for confirmation. (DEM, OSM, and GOOGLE EARTH imagery).

AQUIFERS:

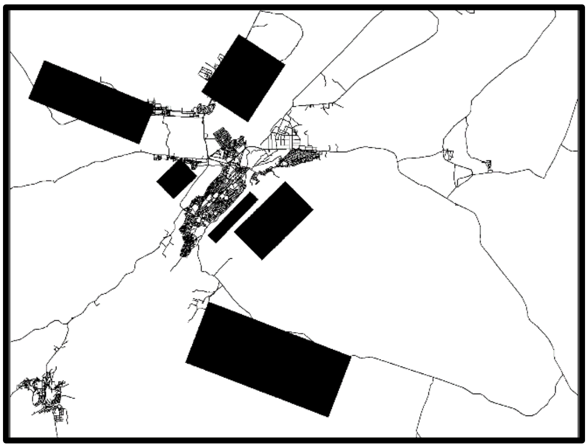


Figure 69: Aquifers. Source: Authors

The highest Potential for aquifer presence has been identified based on an existing hydrogeological study of the area.

WILDLIFE VALUES:

Wildlife location maps have proven to be difficult to establish despite the existence of an extensive inventory of local species within Bousaada, interviews with Experts as well as documents provided from research projects and thesis' have confirmed the existence of over 48 different recorded species in the avian category alone. In addition to various other endemic species that have also been confirmed to exist within Bousaadaa (Mammals, Reptiles, Insects and even fish within the region of El'Hodna), but the absence of concrete maps (or the conditions for the existence of environments for said species) that depict locations of natural habitats as well as feeing/breeding grounds has unfortunately led to the inability to produce the map, but opens up potential for future establishment of such maps.

SURFICIAL GEOLOGY:

In terms of identification of the most suitable land for laying suprficial foundations, surficial geology maps could not be elaborated due to the lack of information, despite the availability of geologic studies and pedology maps, factors like potential erroneous information (old pedology maps which have been modified/corrected) and the unavailability of means to transcribe geologic informations (availability of information but inability to interpret it within our context), has led to the absence of this map within our study context (1968).

EROSION:

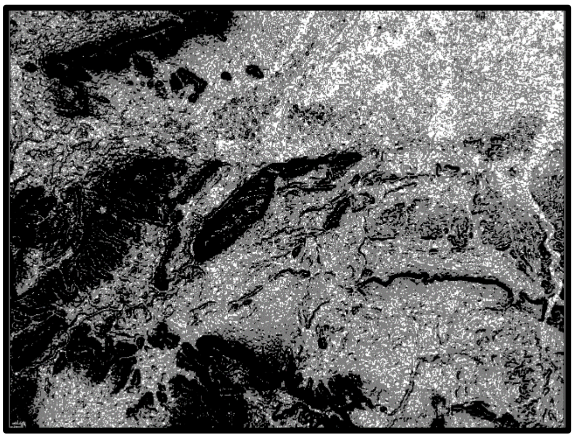


Figure 72: Erosion. Source: Authors.

Producing erosion maps requires taking into consideration both slope percentage and the nature of soil. As previously mentioned due to the unavailability of geological data, and thus the nature of soil, only slope percentage has been taken into account for considering areas of potential erosion.

SURFACE DRAINAGE:

Figure 71: Surface Drainage. Source: Authors.

Have been produced by using Streams maps, representing drainage chanels.

GEOLOGIC FEATURES:

No significant geologic feature seems to be prominent other than Djbel Kerdada, which alongside the absence of concrete data that can highlight geologic features worthy of scientific or historic interest, leads to a broader approach which is represented by the physiographic features maps.

Slopes:

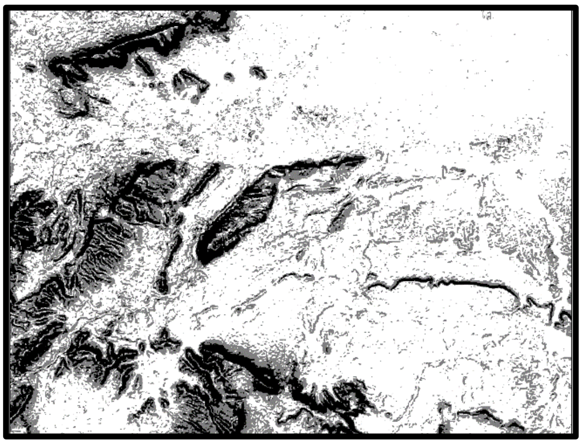


Figure 74: Slopes. Source: Authors.

Slope maps have been synthesized using satellite data (DEM).

Physiographic Features:

Figure 73: Physiographic features. Source: Authors.

Physiographic Features have been identified and manually delineated through the use of satellite data (extracted from DEM)

Urbanized Areas:

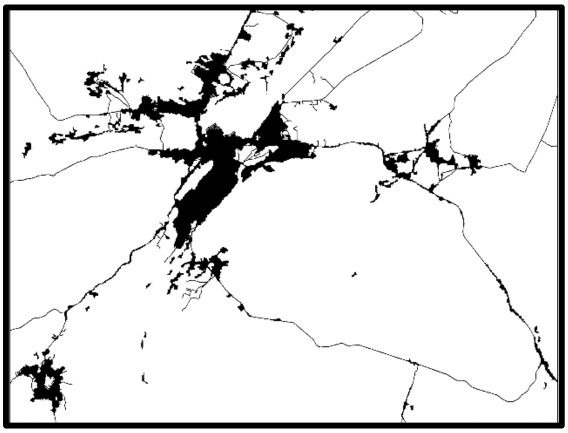


Figure 76: Urbanized Areas. Source: Authors.

Urbanized Areas map resulting from a manual synthesis of satellite imagery (African Living Atlas, GOOGLE EARTH)

Proximity to roads

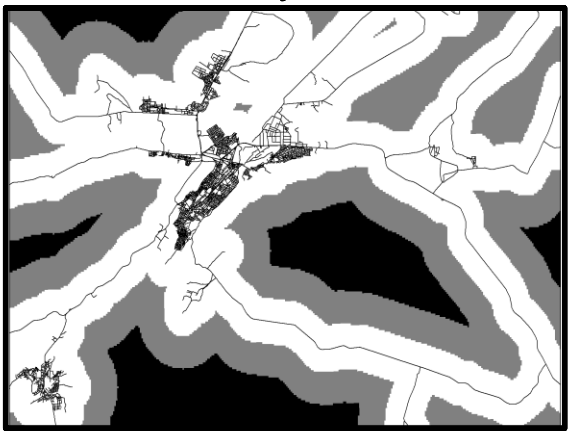


Figure 75: Proximity to roads. Source: Authors.

Proximity to roads was based off existing

Map value categorization for Urbanization compatibility:

In order to establish suitability for urbanization, each map feature has been categorized within 3 values, from lowest to highest in terms of compatibility with urbanization, which allows us to identify areas with the highest tolerance for urbanization.

	Stream Type (1)	**Tidal Inundation (Stream Proximity) (2)**	**Vegetal coverage (type) (3)**	**Slope (4)**	**Vegetal Coverage (Density) (5)**
Least Urbanizable	Primary and Secondary	Flood-prone zones	Agricultural Land	Above 25%	Highest Density
Conditionally Urbanizable	/	Furthest zones from streams	Grassland and Medium density vegetation	25-10%	Medium Density
Most Optimal for Urbanisation	Absence of Streams	Proximity to stream above flood line	Lowest density vegetation and barren lands	10% or less slope	Lowest Density

	Surface Drainage (6)	**Scenic Values (7)**	**Susceptibility to Erosion (8)**	**Physiographic Features (9)**	**Social Values (10)**
Least Urbanizable	Absence of Drainage Features	Scenic Features	10%+ slope	Presence of major Physiographic features	Urbanized Areas And low value areas
Conditionally Urbanizable	/	Urbanized Areas with litte/no viewsheds	2.5-10% slope	/	Secondary, tertiary and last considerations for expansion
Most Optimal for Urbanisation	Presence of Drainage Features (channels and streams)	Areas with prominent views on scenic features	2.5% or less slope	Absence of major Phyiographic features	Prime Value land

	Historic Values (11)	**Road Proximity (12)**	**Aquifer (13)**	**Urbanized Areas (14)**
Least Urbanizable	Presence of significant Historic Landmarks	Furthest from roads	Presence of aquifers	Presence of Urbanized Land
Conditionally Urbanizable	Walkable Proximity to significant Historic Landmarks (50m)	Average distance from roads	/	/
Most Optimal for Urbanisation	Absence of significant Historic Landmarks	Closest proximity to roads	Absence of Aquifers	Unurbanized areas

Map weighing:

Individual map weight has been taken into consideration as an additional factor for considering map influence over the final result (each map is represented by its respective ID) the chart is broken down into 3 categories as follows:

- A: Highest weight/influence. (9.2%)
- B: Medium/average weight/influence. (7%)
- C: lowest Weight/influence (2.5%)

The influence of each map is calculated so that the total always equals 100%,

The maps are categorized according to how influential they are, more tangible factors like slopes and natural barriers or physiographic features that count as direct restrictive factors are considered more impactful than metaphysical factors like land value estimations or scenic view sheds.

Weight Category	**Map ID**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
A				X	X					X			X	X	
B		X	X			X	X		X			X			X
C								X			X				

b. Map Synthesis:

The maps can then be synthesized into various composite maps, according to the categorization of their features:

Urbanizable:

▷ Highest Suitability for Urbanization (Lowest social cost)

▶ Lowest Suitability for Urbanization (Highest social value)

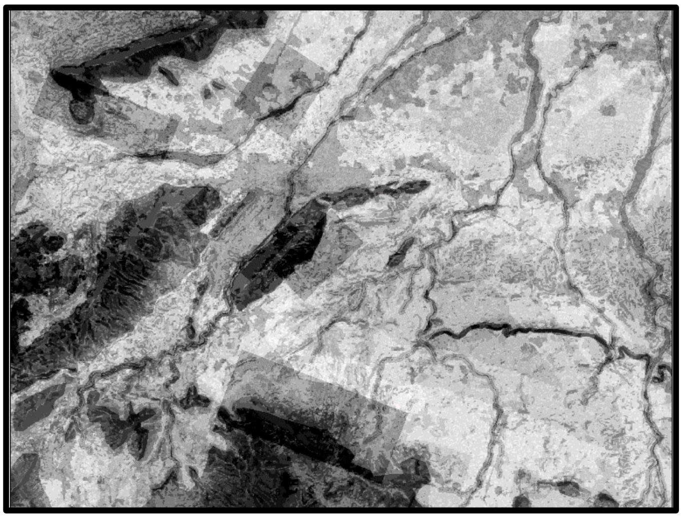


Figure 77: Unreclassified Urbanization suitability composite. Source: Authors.

Reclassified Urbanizable:

Reclassification increases map readability by separating Gradients into multiple categories :

- Optimal suitability
- Conditional suitability
- Unsuitable for urbanization
- Low suitability
- Unsuitable

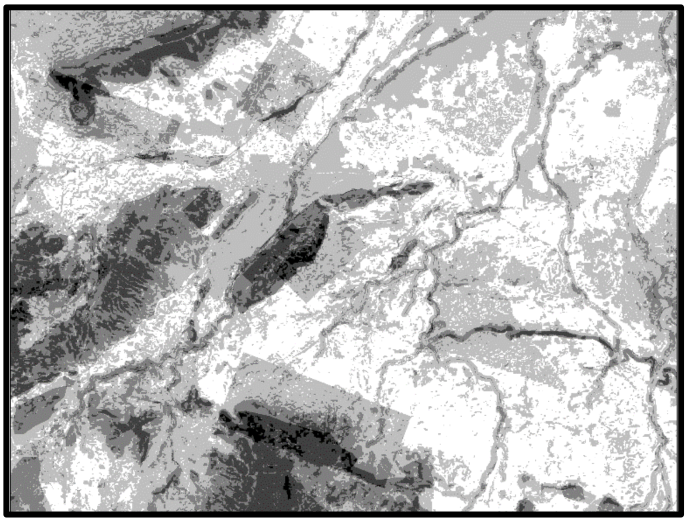


Figure 78: Reclassified Suitability for Urbanization. Source: Authors.

Residential:

Highest Suitability for Residential (Lowest social cost)

Lowest Suitability for Residential (Highest social value)

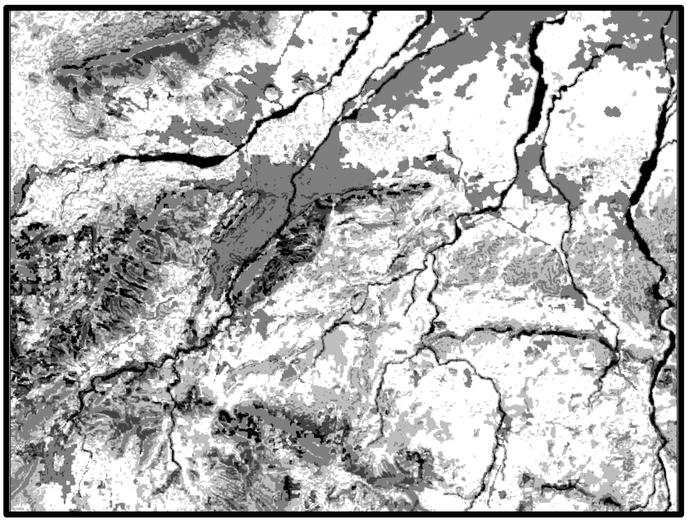


Figure 79: Composite: Residential suitability. Source: Authors.

Passive Recreation:

Highest Suitability for Passive Recreation (Lowest social cost)

Lowest Suitability for Passive Recreation (Highest social value)

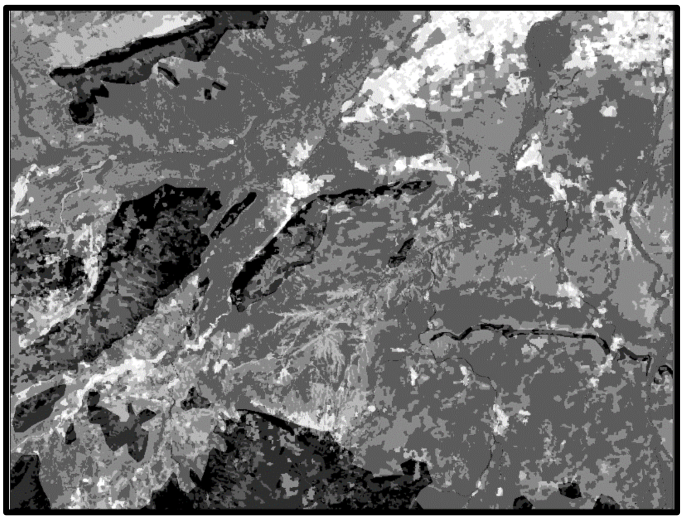


Figure 80: Composite : Passive recreation Suitability. Source : Authors.

Active Recreation:

Highest Suitability for Active Recreation (Lowest social cost)

Lowest Suitability for Active Recreation (Highest social value)

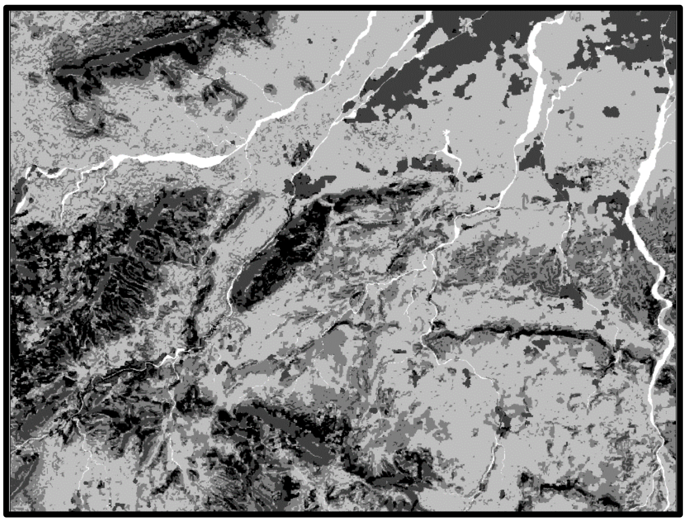


Figure 81: Composite: Active recreation suitability. Source: Authors.

Commercial Industrial:

Highest Suitability for Commrcial Industrial (Lowest social cost)

Lowest Suitability for Commercial Industrial (Highest social value)

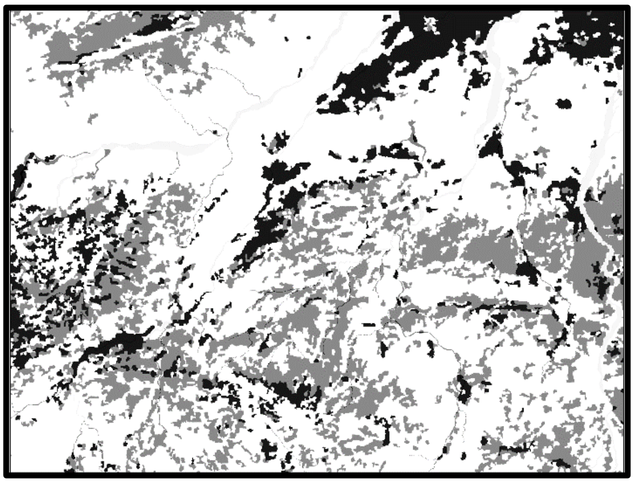


Figure 82: Composite: Commercial-Industrial Suitability. Source: Authors.

Conclusion:

The purpose of this analysis was to demonstrate the possibilities of identifying land compatibility based on a holistic method that gathers different categories and factors within those categories, which when followed by a criteria-based deconstruction of each component, and individual reassessment within an elaborated value system, presents us with a set of indicators for specific purposes that can be predefined.

In other words planning in this context becomes more like a game of defining what factor we want to assess, assigning criteria to those factors, gathering as much data about the natural and built environment as possible, processing the data for categorization, and superimposing and then consulting data for the most optimal course of action within the researched criteria.

In our case the operation was successful at defining clear locations of high compatibility with certain activities and types of land usage which matched early expectations, in essence the method remains exploratory and many other factors can contribute in creating a larger database, thus making the results for compatibility even more accurate and opening up a larger spectrum of possibilities for different categorizations and land usage, contributing to the creation of a more optimal mode of land usage for man within his environment through the use of natural cues.

4) OASIS OPERATION: A REGENERATIVE INTERVENTION.

1) Studying the context:

The approach taken for the analysis within the space of the oasis is that of the four-system subdivision. By examinating the area according to four main components: Plots Built , non-built, and road systems.

Through this, The first and main issue that can be observed within the seems to be is its slow degradation from being built upon, the oasis represents the most important factor for Bousaada's permanence, as it is supposed to be its main food source and ecosystem regulator, An analysis of the built surfaces starting from the oldest most visible maps (2001) up until more recent times (2018-2022) shows that a considerable part of the oasis (176146 m2 or 14% of the total surface) is comprised of built surfaces.

Figure 85: Built space within the oasis in 2001. Source: Authors.

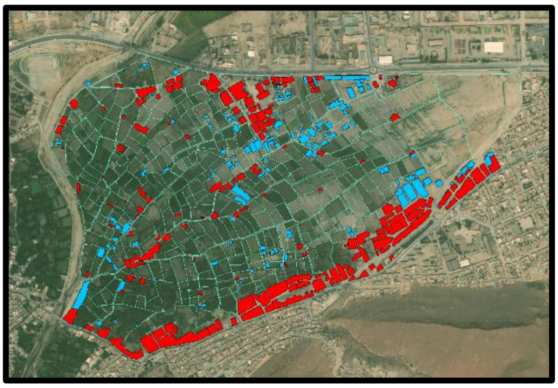


Figure 83: Built space within the oasis in 2018. Source: Authors.

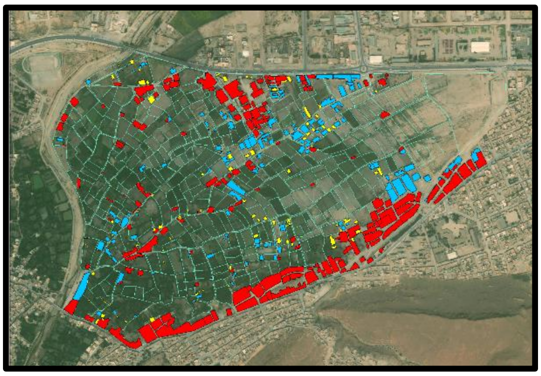


Figure 84: Built space within the oasis in 2022. Source: Authors.

Built surface concentration is more prevalent towards the south-eastern perimeter, but as it can be seen a considerable amount of surfaces have also been migrating towards the center of the oasis.

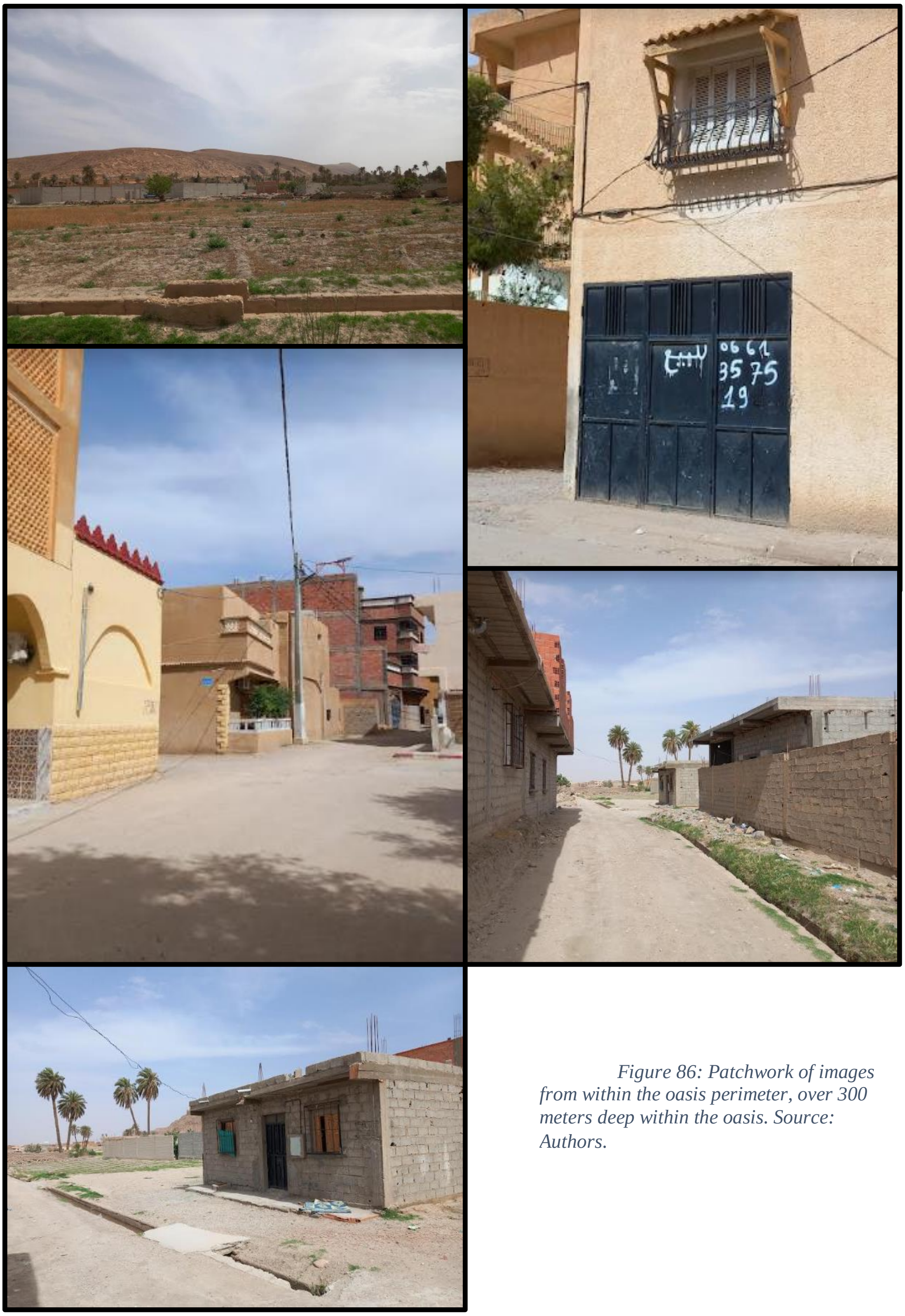


Figure 86: Patchwork of images from within the oasis perimeter, over 300 meters deep within the oasis. Source: Authors.

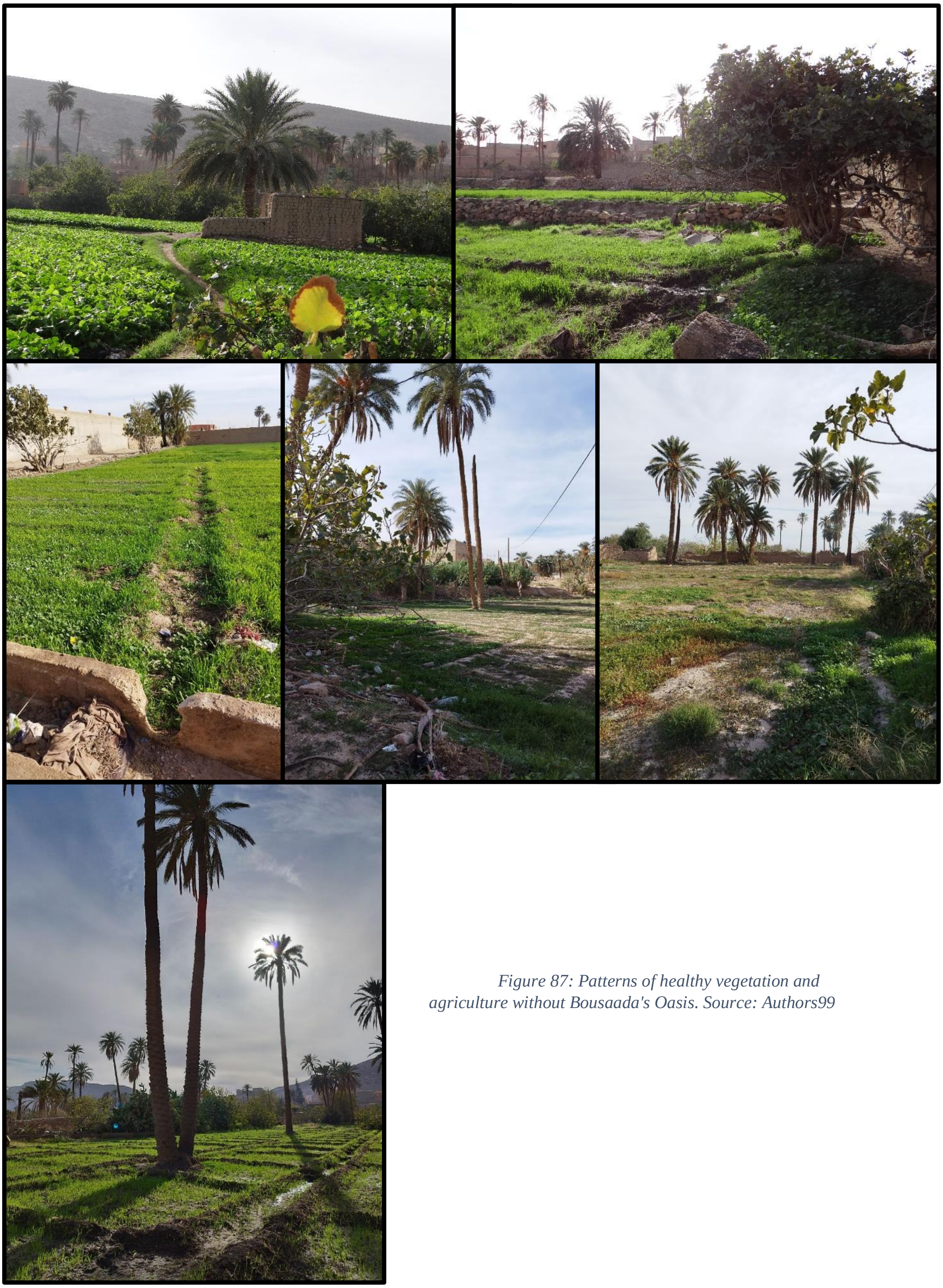


Figure 87: Patterns of healthy vegetation and agriculture without Bousaada's Oasis. Source: Authors99

2) <u>Defining Operation perimeter:</u>

In order to locate the sites most adapted for operations of restoration within the oasis, an overall compatibility study is done using geographic mapping and criteria-based area selection:

The initial criteria for selection were :

- Built areas : the goal being to minimize having to build on top productive oasis land (farmland) by instead choosing already-built surfaces for restoration operations.
- Unbuilt areas that do not appear to be used (based on chronological map observations, example : areas suffering from desertification) : while they are not built, they also represent unproductive land, which is also a target for any opration aiming for restoration within the oasis.
- Only peripheral areas : The main issue within the oasis is the transition of the concrete and general idea of building form the periphery towards the center, so the aim is to only occupy the rim of the oasis.

Secondary criteria for selection involve internal evaluation, which comprises Fully built zones, Partially built zones and Unused unbuilt zones.

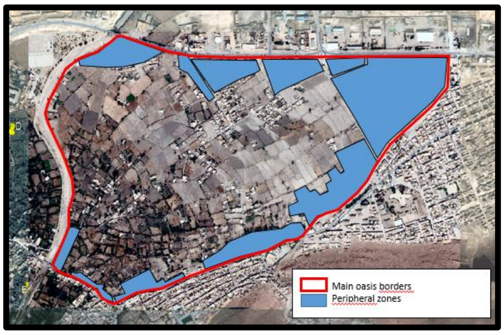


Figure 89: Peripheral built and unbuilt areas within the oasis. Source : Authors

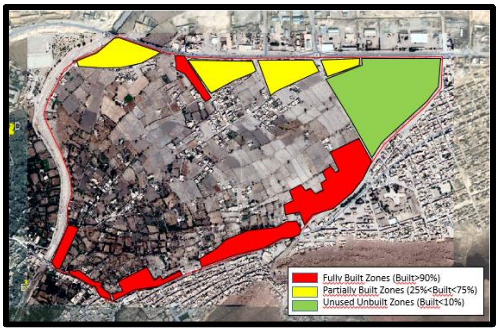


Figure 88: Compatibility study for project site. within oasis space. Source: Authors.

In the context of our operation, the restoration of the oasis aims to be a gradual reconquest of the built areas, as such the most optimal site for a project that aims for that is the unbuilt, unused area.

The location poses a strategic and symbolic advantage, as it is at the tail end of the oasis and can serve as an outpost for overlooking the operations within it, the immediate follower would be the remaining peripheral areas, as they would be next in line for operations of demolition to reclaim the land as agricultural property.

In parallel satellite mapping has been used for confirmation of land usage to support the previous proposition, the delineated area is qualified as "bare ground" in light of its unproductive nature over the course of several years.

Figure 91: Land use Satellite view of Oasis area. Source : Authors.

Figure 90: Land use Satellite view with selected areas within the oasis. Source: Authors.

3) <u>Operating within the Perimeter:</u>

The next part of the operation consists of inserting the delineated area within the existing pattern of agricultural subdivision, the conceptual process follows a logic of an alternate design proposition for land subdivision:

Instead of proposing a rigid orthogonal grid, the process involves recreating patterns based off of centers of already-existing farmland subdivisions, these centers are extended to create new centers with the same old patterns.

The positioning of the new centers or cores is based on the old cores distances (proximity to borders and to each other)

Figure 93: Existing subdivision within the selected oasis area. Source: Authors.

Figure 92: Existing Cores for subdivisions within the selected Oasis area. Source: Authors.

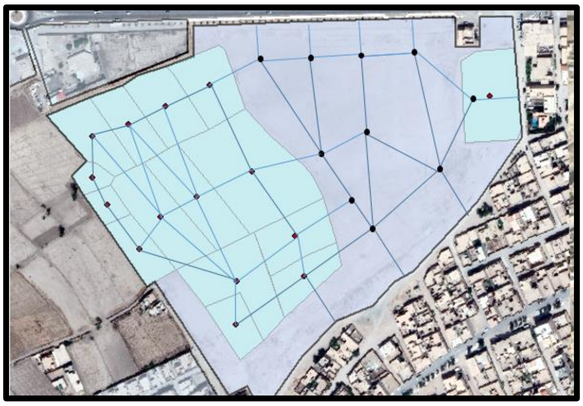


Figure 95: Pattern extraction and continuation through the study of existing "Cores". Source : Authors.

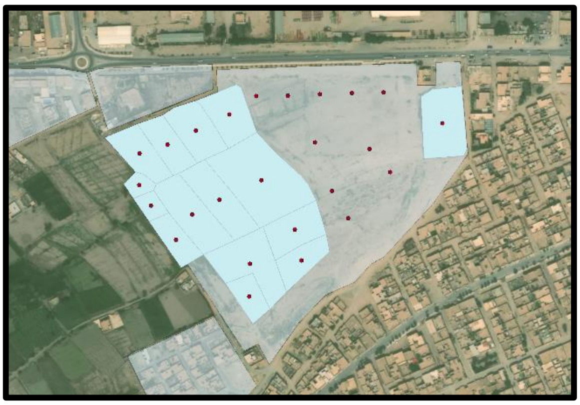


Figure 94: Establishment of new cores within selected area. Source: Authors.

The creation of area subdivisions is done using Thiessen polygons, it is based on the same mathematical principle of most geometric forms found in nature, mainly patterns observed in land in periods of drought.

This is applied as a proposition for an alternate mode of land subdivision, which applies principles found in nature for surface elaboration.

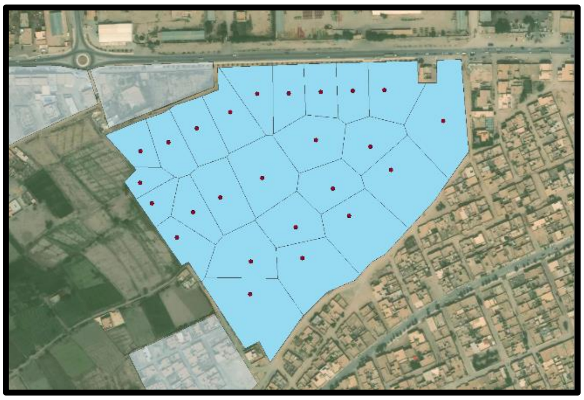


Figure 96: Land subdivision accoring to new cores by using Voronoi. Source: Authors.

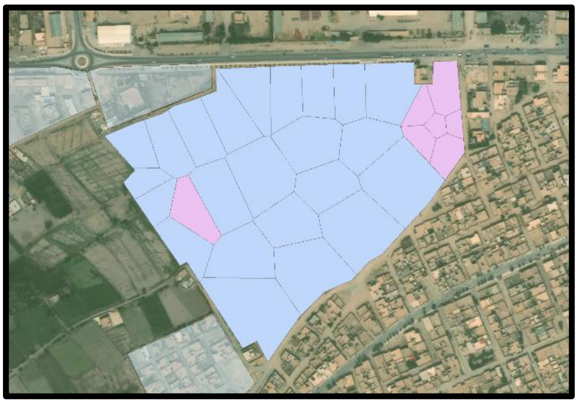


Figure 97: Delimitation of main and secondary terrains for project implmentation. Source: Authors.

What follows is the strategic selection of surfaces for project implementation. Aiming for easy access for the main facility, and the creation of a pattern through the farmland conservation subdivisions which links the main facility to the secondary unit.

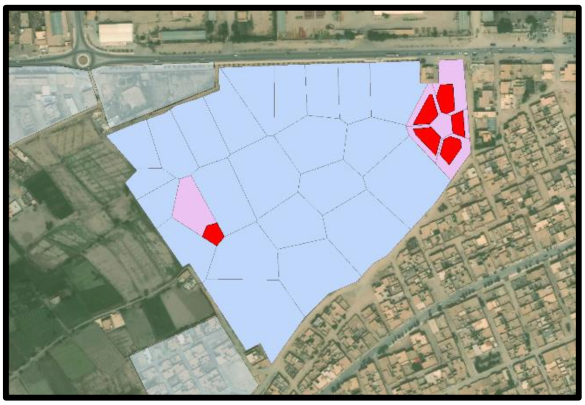


Figure 98: Outline of Project units within selected terrain.Source: Authors.

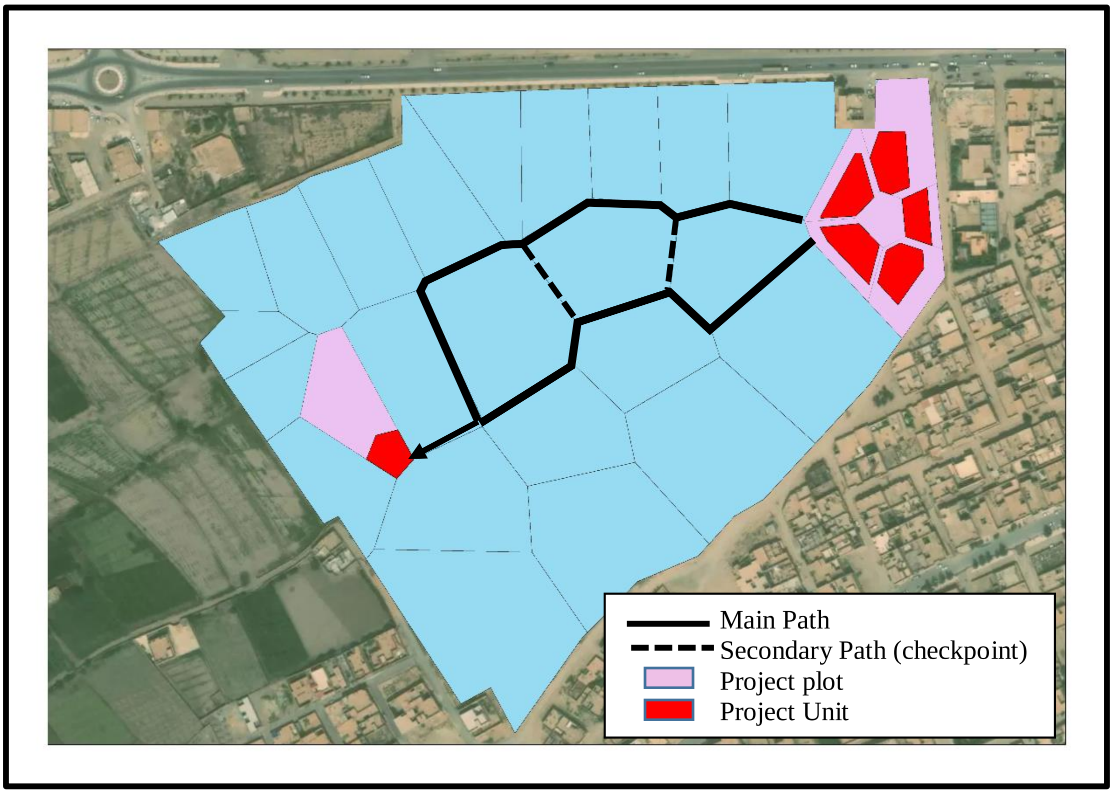


Figure 99: Final Devlopment scheme for project. Source : Authors.

The proposed intervention results in the creation of a facility that is spread across the surface of the selected area of the oasis while only occupying a fraction of its surface. Both the main and secondary units are placed at opposite poles while remaining connected by a created path that penetrates the proposed farmland subdivision without disturbing the function.

The proposition aims at promoting exploration of the oasis' space and farmland activities by exploding the function of the project across the area of intervention, creating points of interest along the way in the form of checkpoints (tents) as refuge from sunlight and for respite, but also as a point to reach while progressing through the proposed paths.

5) Introduction to project: Scientific Research of Natural Resources, Learning and Leisure Center:

The conceived project is a Scientific Research of Natural Resources, Learning and Leisure Center. The idea was initiated from the thematic orientations, as the idea of studying Bousaada's ecosystem and resources is further encouraged by having an establishment that is dedicated not only to the research and study of these local natural elements but to also serve as a teaching facility for youth both in Bousaada and on a national scale. The idea being that we can teach local youth about their own environment and the value of all its components and why it is important to work towards conservation and restoration strategies to ensure their future permanence.

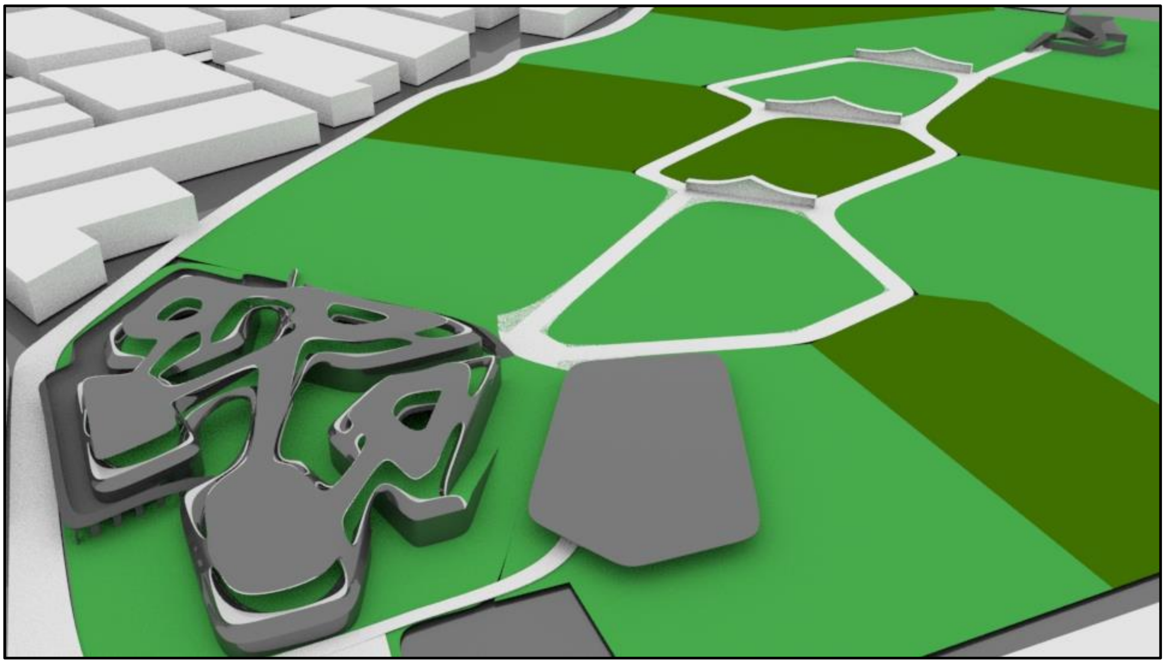


Figure 100: Urban-Scale Project Overview

The secondary function of the center which is leisure, has been introduced as part of the strategy for the conservation of the oasis space. A theme that already exists within the context is that of tourism, being a key point in Bousaada, indirectly promoting part of the oasis as a leisure space within our project aims to prompt locals to improve the quality of the oasis and its features. Thus encouraging stay at the accommodation spaces which can double as hotel rooms for visitors, as well as exploration within the oasis' space which the project extends to through a route that links the main facility to the auditorium while providing multiple checkpoints for resting under shade and viewing expositions.

a. Project concepts:

The initial conceptual stages involved researching the most optimal configuration for the context. What we opted for was a separation of the program into interconnected functional units configured as an introverted entity. Which would represent the main activities within the center, this configuration was adopted for many reasons:

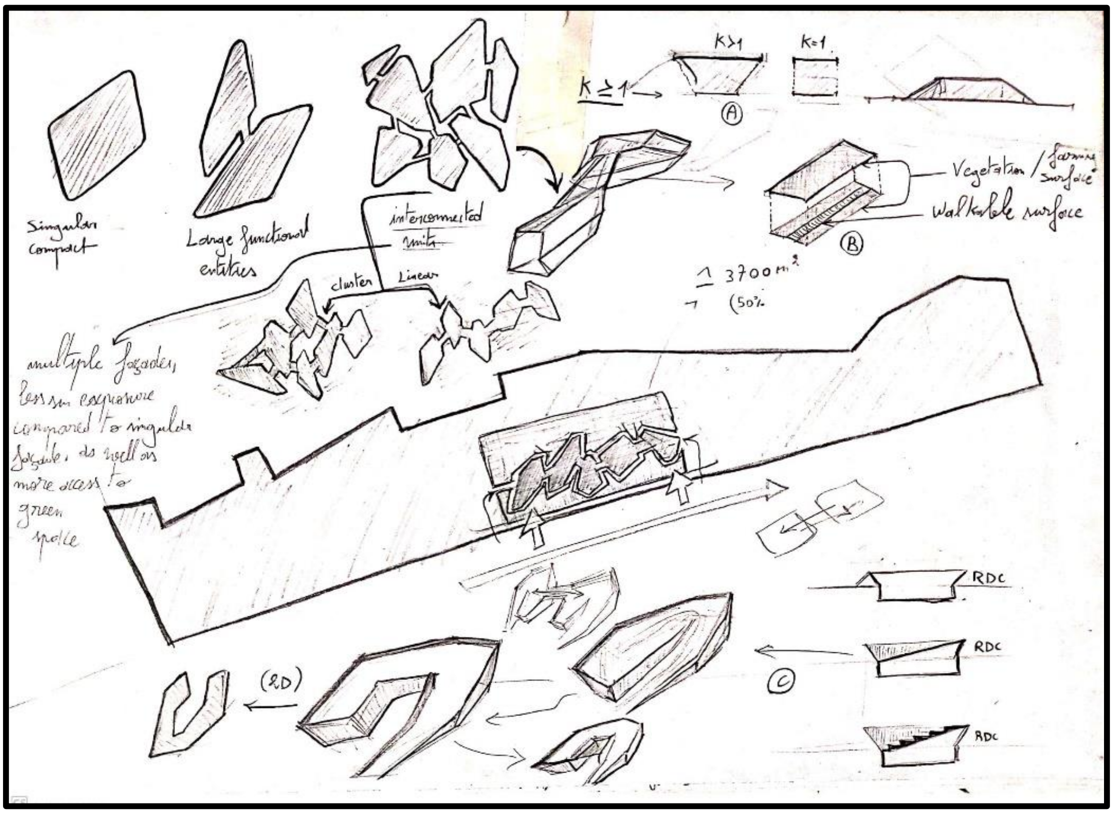


Figure 101: Project Principles sketch board. Source: Author

- Functionality:

Separating the program into individual units allows for a more clear functional readability and more optimal use of spaces as different spaces with different properties require different configurations and conditions to function properly.

- Comfort and environment:

The scattering of the program in the form of multiple entities instead of one large bloc, as well as the introverted configuration, can ensure better comfort in terms of sunlight exposure, as individual and homogenous structures get more sun exposure during the day, increasing the temperature of the materials, while this configuration allows for the individual unites to provide shade to one another, these notions are also explored in materiality as the structural system is comprised of load-bearing concrete walls that are

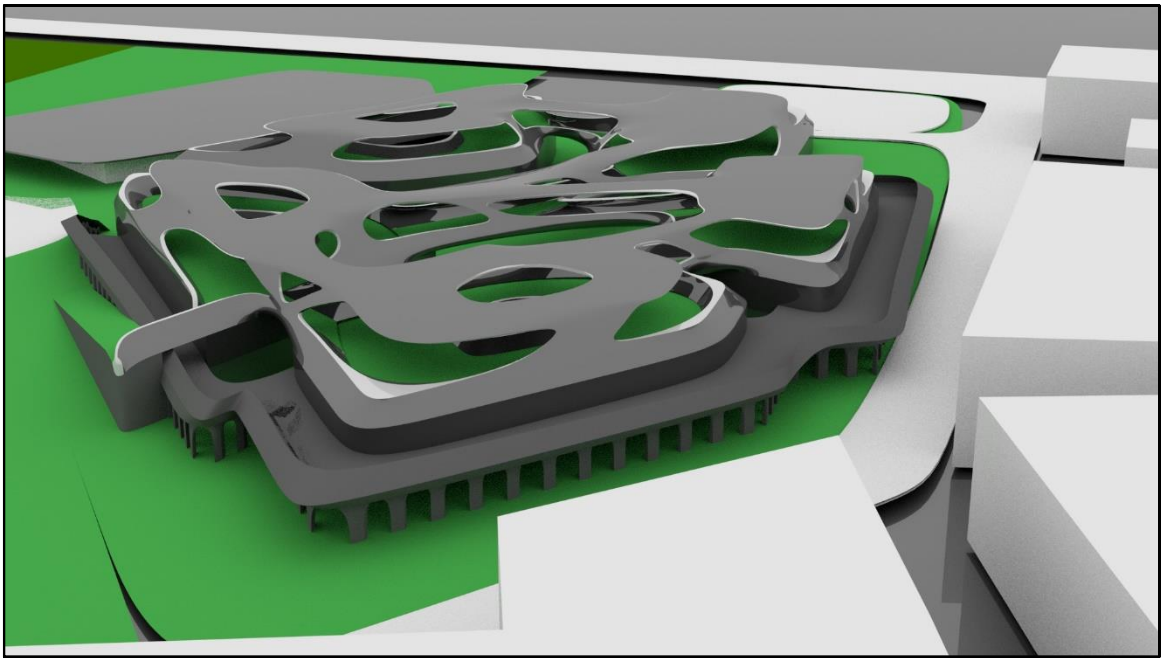


Figure 102: Integrated shading system facing south side. Source: Author.

- Access to exterior space:

An exploded configuration promotes transition from one space to another through open space, increasing human-nature interaction, thus improving physical and psychological comfort.

- Exploration of Interconnectivity:

Unit multiplicity means we can focus on providing interesting modes of interconnection, as spreading a project over multiple entities still requires providing a visible link between its components. Interesting patterns can promote exploration and discovery within a project, further increasing the appeal of the latter.

The project also incorporates notions of vegetal pattern continuity, as the ground level vegetal space remains continuous on its way up the terrace level, the goal being to reinforce principles of interlinked environments, diverse components of the soil (bacteria, water, minerals, decomposers etc…) which allows the terrace soils to perform similarly to agricultural surface soil.

It is also important to mention that the project is semi-buried in the soil at a depth of 1 meter, the removed soil is then used as a filler for the upper terrace level which potentially helps with the integration of local bacteria and soil components which further reinforce the project's identity as a local entity within its context.

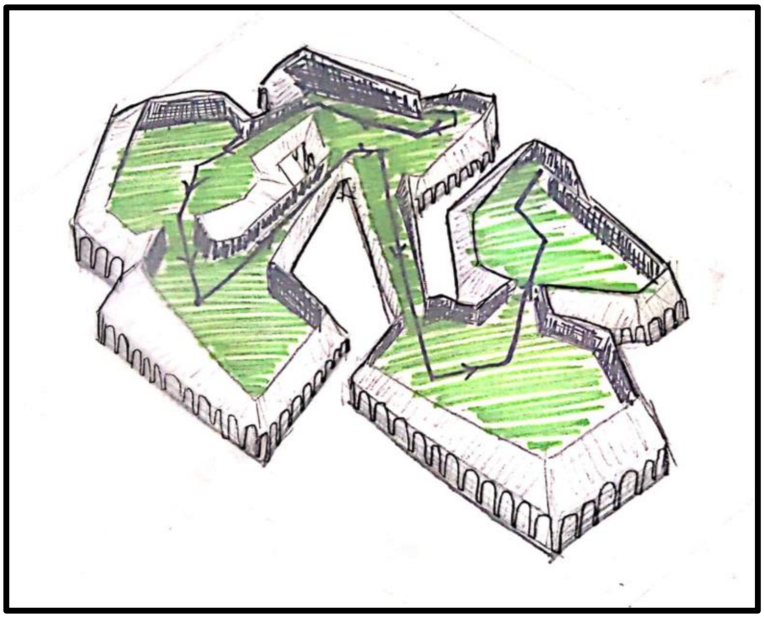


Figure 103: Early sketch showcasing roof and elements interconnectivity. Source : Author.

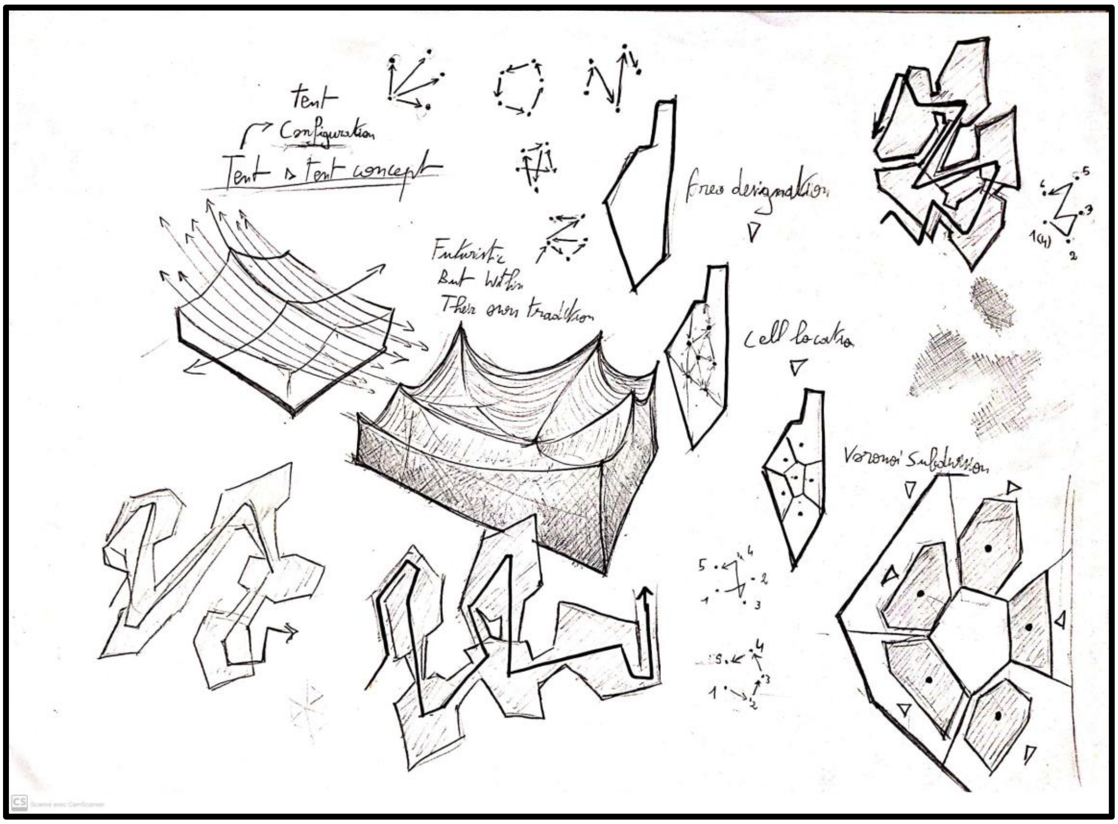


Figure 104: Exploration of possibilities and modes of interconnectivity, as well as models for local morphological integration. Sourche : Author

b. Project genesis:

Main unit:

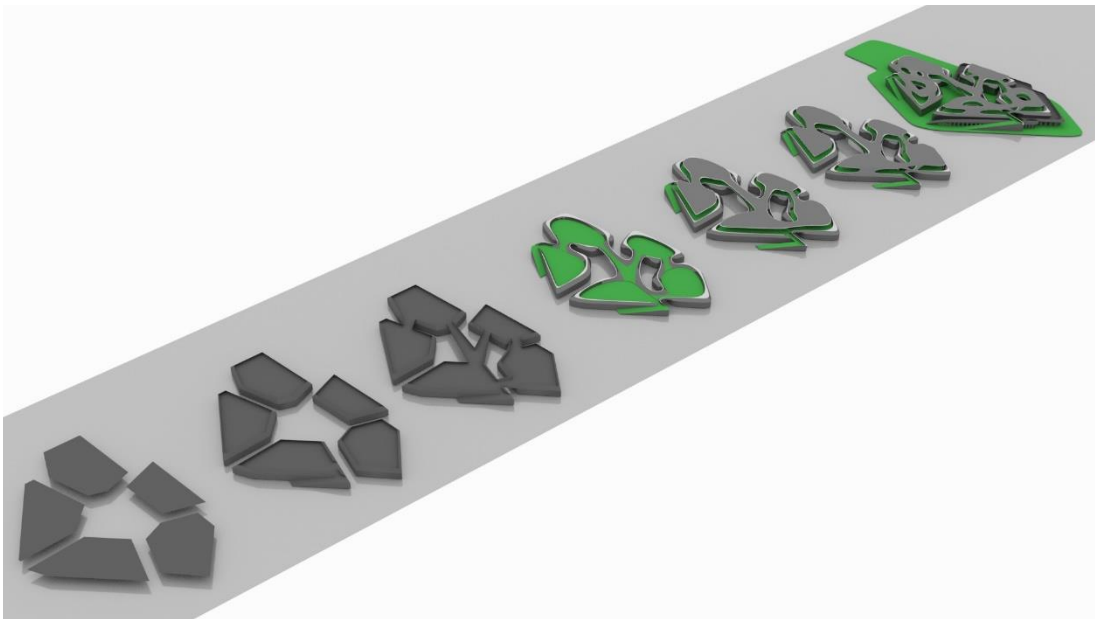


Figure 105: Process of form-elaboration for main units.. Source : Author.

The project rises as a set of units which are organized in an introverted configuration, the units are then connected at the top by bridges which are then shaded via a roof installation, certain units are then perforated in order to introduce sunlight to live spaces.

Secondary unit:

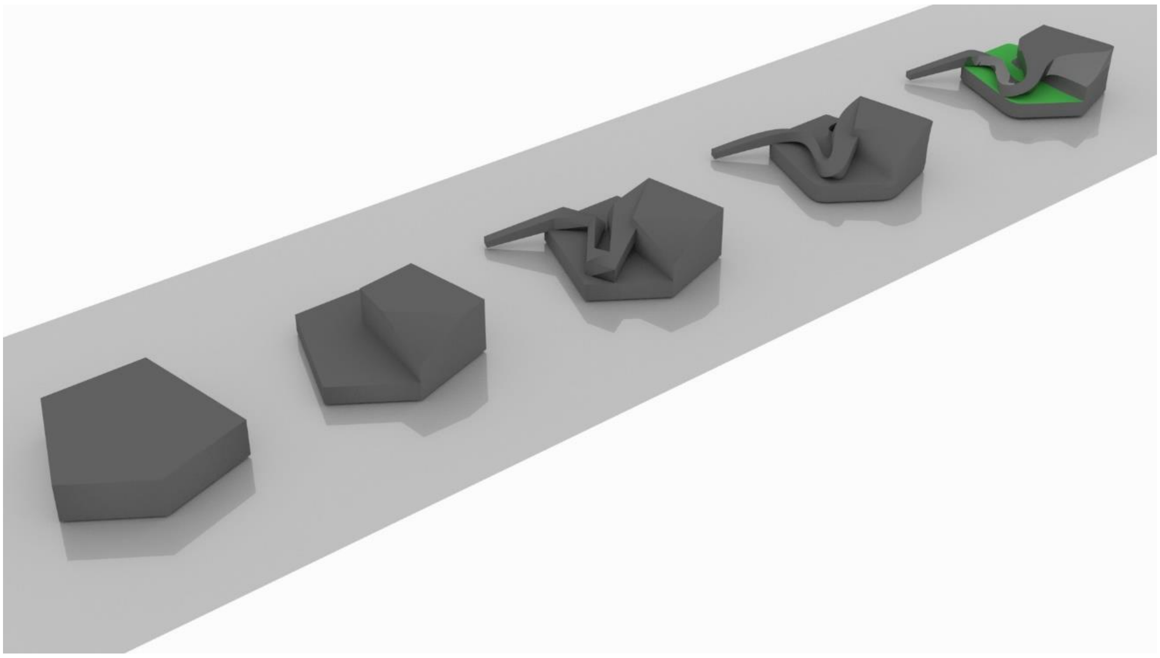


Figure 106: Auditorium Genesis. Source : Author.

The auditorium unit serves as a terminal vista for the urban path, an interesting perspective to reinforce that idea was the integration of an accessible upper level which grants a peripheral view of the whole oasis from over a 6 meter height, serving as yet another goal or finality that visitors should look forward to, as well as a signature object that can be seen from a distance as an interpretation of the iconic curvature of sand dunes.

c. Program:

1) Organizational scheme:

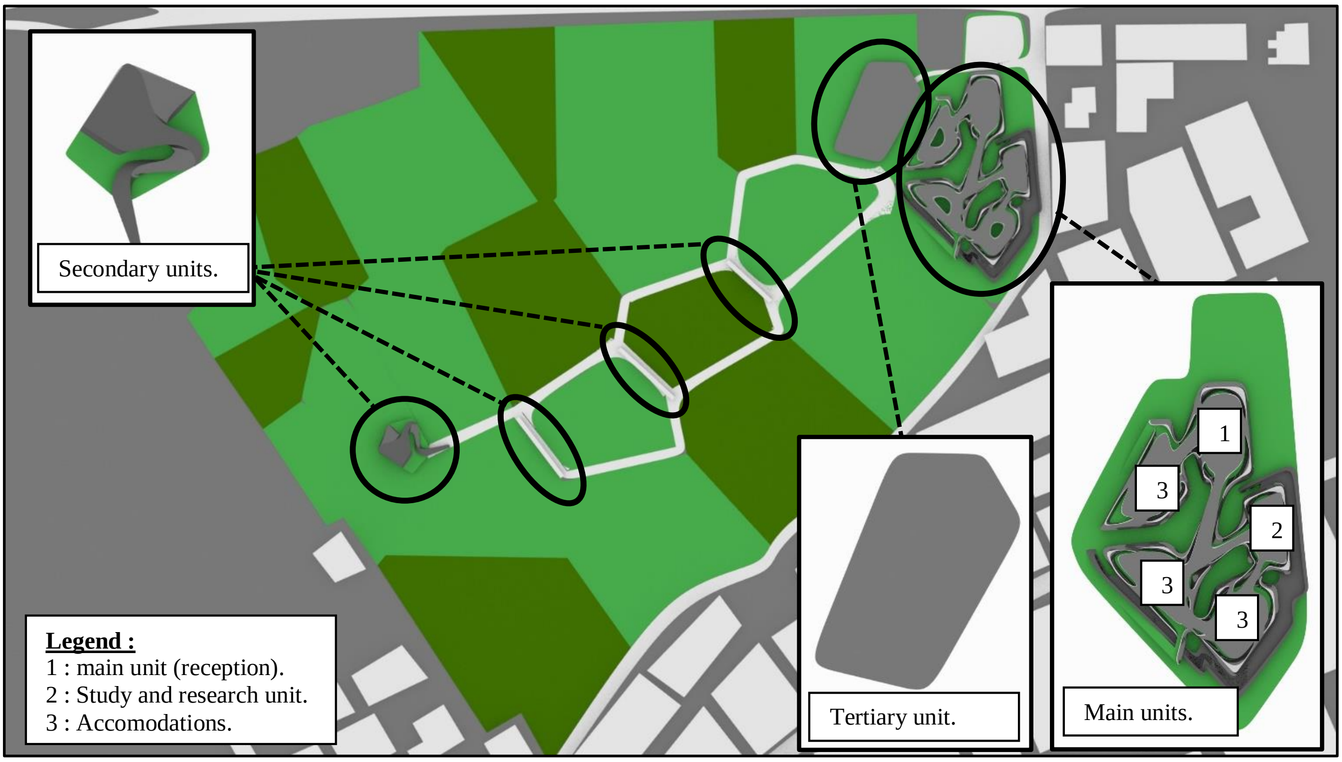


Figure 107: Overview of project layout and main functions. Source: Author.

2) Spatial program:

	Unit	Spaces	Number of spaces	Surface per space (m2)	Individual totals	Unit totals
		Entrance Lobby	1	70 m2	70 m2	

Main units.	Main Unit (Reception)	Reception Space	1	230m2	230 m2	845 m2
		Staff room	4	20 m2	80 m2	
		Technical area	1	40 m2	40 m2	
		Sanitary	1	40m2	40 m2	
		Kitchen	1	160m2	160 m2	
		Canteen	1	225 m2	225 m2	
	Study and research unit	Circulation and Exposition space	2 (1 per floor)	70 m2	70 m2	844 m2
		Teaching Room	6 (3 per floor)	Room1:65 m2 Room2:80 m2 Room3:90 m2	470 m2	
		Laboratory	6 (3 per floor)	40 m2	240 m2	
		Sanitary	2(1 battery per floor)	32 m2	64 m2	
	Accommodation unit 1	Accommodation Space	19 (9 for ground floor, 10 forfirst floor)	Room 1: 30 m2 Room 2: 40 m2 Room 3: 50 m2	580 m2	1090 m2
		Study Room	6 (3 per floor)	50 m2	30 m2	
		Leisure Space	2 (1 per floor)	240 m2	480 m2	

	Accommodation unit 2	Accommodation Space	21 (10 for ground floor, 11 for first floor)	Ranges from 20 m2 to 40 m2	644 m2	1294 m2
		Study Room	6 (3 per floor)	Room 1: 35m2 Room 2: 40m2 Room 3: 50m2	250 m2	
		Leisure Space	2 (1 per floor)	200 m2	400 m2	
	Accommodation unit 3	Accommodation Space	17 (8 for ground floor, 9 for first floor)	Ranges from 25 m2 to 43 m2	561 m2	1281 m2
		Study Room	6 (3 per floor)	Room 1: 35 m2 Room 2: 40 m2 Room 3: 50 m2	250 m2	
		Leisure Space	2 (1 per floor)	235 m2	470 m2	
						5354 m2

	Unit	Spaces	Number of spaces	Surface per space (m2)	Individual totals	Unit totals
Secondary Units.	Auditorium	Leisure/exposition lobby	1	160 m2	160 m2	885 m2
		Laboratory	1	100 m2	100 m2	
		Auditorium	1	260 m2	260 m2	

		Sanitary	2	30 m2	60 m2	
	Open-air resting /exposition spaces	Exposition/ resting Tents	3	Tent 1: 85 m2 Tent 2: 110 m2	305 m2	305 m2
						1190 m2

	Unit	Spaces	Number of Spaces	Surface per space (m2)	Individual totals	Unit totals
Tertiary Units.	Staff Accommodations (6 apartments)	Bedrooms (3 per apartment)	18	Room 1: 12 m2 Room 2: 16 m2	240m2	
		Circulation Space (1 per apartment)	6	21 m2	126 m2	
		Kitchen (1 per apartment)	6	9 m2	54 m2	

		Living room (1 per apartment)	6	23 m2	138 m2	588 m2
		Sanitary (1 per apartment)	6	5 m2	30 m2	

	Unit	Spaces	Number of Spaces	Surface per space (m2)	Individual totals	Unit totals
Open Space	Main Unit	Exterior Space	1	4770m2	4770m2	
		Connected Green Roof	1	3000 m2	3000m2	
		Interior Greenery	3	100 m2	300m2	

	Secondary Unit (auditorium)	Experimental field	1	2850m2	2850m2	130852 m2
	Tertiary Unit (Apartments)	Apartment Garden	12	21m2	232m2	
		Accessible Green surface	1	3400m2	3400m2	
	Remaining Surface	Conservation Subdivisions	/	116300m2	116300 m2	

The total surface of the intervention area is measured to be about 125579 m2, the total restituted green space through roofing systems and open spaces is about 130852 m2 which means that we have been able to effectively restitute a portion of the built space (about 4%) as green space via the help of green roofing surfaces.

Total built surface on plane: 6100 m2

Total built surface accounting all floors: 7132 m2

Total oasis area surface: 125576 m2

Built surface percent : 4,85% (6100m2)

Conclusion:

"In the quest for survival, success and fulfillment, the ecological view offers an invaluable insight, it shows the way for the man who would be the enzyme of the biosphere-its steward, enhancing the creative fit of man-environment, realizing man's design with nature."-Ian L.McHarg.

Nature operates as a system, all-encompassing, and its view as a source of solutions to modern city-scale problems does not stem from a naturalist's view of the world, but from a factual, scientific and reasonable point of view, natural systems have times and times again proven their resilience, which is a result of their immense capacity for adaptation, that is what makes their permanence, in this light, we humans have to be more conscious of our role, as we are not the masters of the game, we do not set natural rules, we only play by them, constantly attempting to overcome them, but for the long term both survival and success can only be found in cooperation, integration and understanding.

In recent times, this Ecological philosophy has seen a rapid gain in attention, and for good reason as the planet's environment has suffered more and more from the recklessness of man, we have become more aware of our impact and of how the modern consumerist society has affected the world we live in, and in more mischievous ways than we have noticed, and from the impact of the degradation of our land, streams, forest, skies and animals, we have understood that we are next in line, IanMcHarg, the author whose book "Design with nature" inspired the theme of this thesis, was very aware of this, being an advocate of the conservation of the natural, he had understood that there is more for us to gain in our environment than mere natural scenes to enjoy, if notions of urbanism and living, not only at a small, but also much larger scale are to improve in the upcoming years, then this very line of thinking that involves ecological considerations must be heavily implemented.

In our quest to accomplish that, multi-layer geographic map analysis has shown to be a very effective tool, as the understanding of aforementioned systems requires the ability to perceive them, which is exactly what this method has provided us, by defining the most important local components to a context and isolating these same individual component across a defined geographic limit, ranking each component internally and thus creating a value system, which when recomposed allows us to visualize the intricacies of the local natural ecosystem and build a visual inventory containing the most to least valuable elements within that same system, as well as provide indicators for usage compatibility based on certain isolated or overlapping criteria, in essence, what this whole process has allowed us to produce, is sensible indications of how to use the land according to existing natural phenomena.

A substantial amount of work has gone into gathering the necessary data, mapping and overlaying it, as we cannot cooperate with a system which we have no information about, and the integration to Bousaada's delicate balance is no easy task, even the finality of the work that has been presented is only the beginning for an even deeper understanding of the underlying factors that compose Bousaada's ecosystem, so far we hope to be able to coexist and effectively integrate into each other, but there is optimism for the possibility of even higher and deeper modes of co-integration and coexistence

And so Bousaada is a very sensible example for this type of intervention, which is based upon natural factors and systems, both of which are very present and in a great variety within the core of Bousaada and its surroundings, once again the strategic position of the city has provided it with one of the most unique ecosystems that one can imagine, and in this uniqueness the criteria that compose it's ecosystem are just as unique, our intervention in that context has allowed us to highlight those components individually in a map format, as each one was subject to internal classification following a flexible value system, thus for each feature a value gradient has been established to categorized from highest value to lowest, followed by an operation of overlapping to create different maps based on criteria for different usage like conservation or urbanization and so on.

The objectives that this approach looks to achieve are to highlight higher value features and areas within Bousaada, Provide indications for large scale interventions in a way that promotes functional compatibility with the environment, and improve human-nature interactions by protecting important natural resources and allowing to design around them.

A myriad of problems are solved when the aforementioned conditions are studied, through the understanding of the impact of natural elements like wind, water and soil, high risk and potentially risky areas are identifiable, and thus can be avoided for construction, areas of high value, whether they are scenic or scientific or vital for survival are also highlighted, allowing for consideration before any intervention is proposed, similarly areas with a high potential or compatibility with a certain activity or function are also highlighted, as an example locations situated directly above aquifers exhibit a high compatibility with activities like agriculture, this whole process translates into a mode of land usage that is based on compatibility with the existing environment.

What this means is, we are heading towards a form of coexistence with the natural environment, where before proposing interventions we have an overview of land compatibility with its inherent values and features, that compatibility is a strong indicator for human permanence on that land, it ensures that we can intervene in a way that allows us to take advantage of the existing positive parameters, and outsource a lot of our processes where instead of providing a third-party or more to enable a certain activity, we obtain the environmental advantage, thus facilitating and even improving on our own operations within the location.

In our project/intervention, this allows us to freely proceed in areas where there are no constraints to development…

The prospects for this study remain open, and the research is exploratory, in hopes to increase attention to matters of environmental consideration for any attempt at future land usage, for the land itself is the most apt at guiding how we use it.

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I. First Axis : Project Presentation

1. *Project Idea (Proposed Solution) :*

- The Startup project is environmental in nature, and aims to provide services for oasis ecosystem preservation within Algeria through the use of a digital interface (software).
- The idea started while working on the the thesis thematic , while using a methodology which consists of multi-layered geographic map analysis, the goal being to create maps that can help preserve Bousaada's Oasis ecosystem, working on GIS helped the process But the process was still very manual and unspecialized, which sprouted the idea for a specialized version that would lock-in an interface for a specific usage, which in our case is the preservation of Oasian ecosystem. The process includes locking-in our own parameters and components of the ecosystem to have a clear plan of action and parameters to take into consideration for that exact type of ecosystem, which will then allow for widespread application in other Oases within Algeria.
- The key issue being the degradation of Oases on a national level, with the increase in climate issues and the global response to rising environmental threats, a resource as precious as the oasis which is present in large numbers in our country (over 93000 hectares) is in great danger of deterioration, and with it not only being a major food source for many cities and provider of jobs on top of being necessary for human permanence, it is absolutely vital to establish ways for more efficaceous ways to preserve those spaces
- The mode of operation involves gathering data of different fields that all represent major components of local oasis ecosystem, the data is interpreted in the form of georferenced maps using satellite teledetection technology.
- Each map is broken down into multiple degrees that fit within a value system.
- Each sub-component is then evaluated and inserted within a value system for interpretation.
- These individual values serve as basis for a multi-criteria based land-use affiliation.
- The result is a composite map of different propositions for land usage based on accurate scientific data of the local natural features that are part of the oasis ecosystem.
- The goal of the maps produced is to identify highest value areas based on specific criteria (importance to the ecosystem, scientific value, social value, engineering value…etc), and to propose strategies based around the existing highest and lowest values, as well as land use compatibility with existing natural parameters.
- This in turn allows us to identify areas of lowest value in terms of environmental and ecosystem impact and to identify areas most suitable for certain land uses, all while

retaining areas of highest value which represent the most important components of the oasis ecosystem and protecting them.

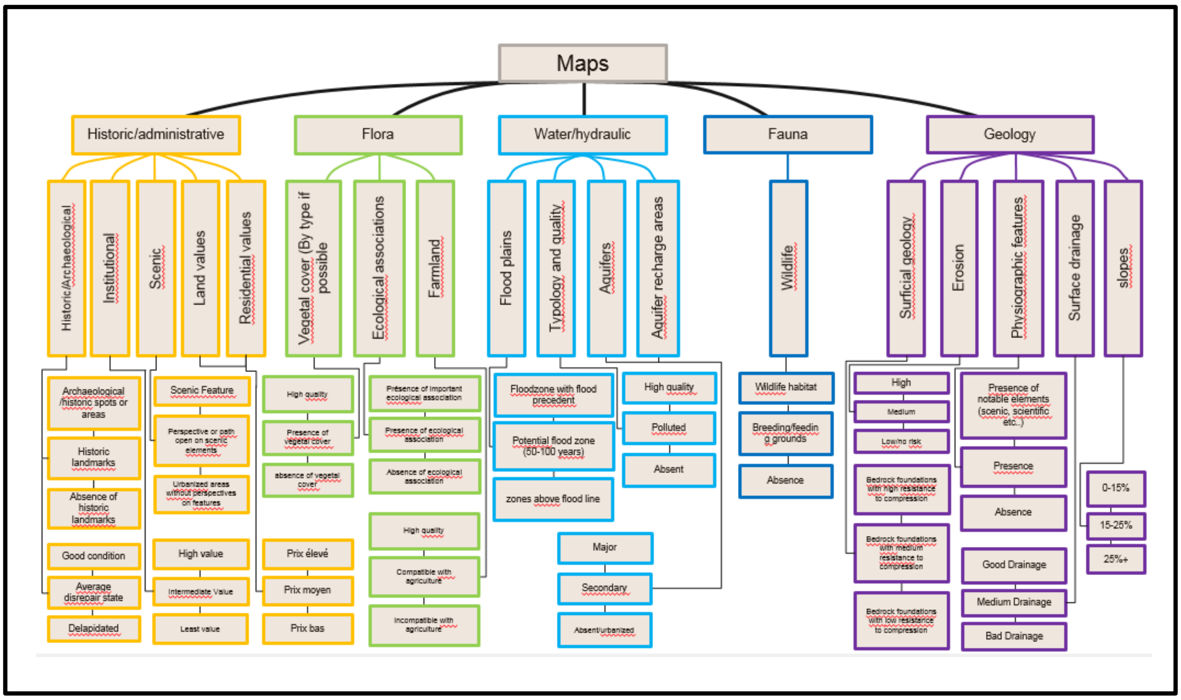
- To recap, The goal is to translate the interdisciplinary process into a digital framework, and then export the model to other context of similar nature (other oass), creating ground for new understanding of local

2. Suggested Values

- Environmental performance : the app has the potential to drasticly improve the way the environment is considered, increasing the visibility of important resources and outlining them, thus improving our usage of them and allowing for better strategies for conservation.
- Social performance : It allows to approach the local environment in a more human way and to consider Elements of ecosystems as not only valuable and necessary for survival but also as important assets for social and cultural considerations.
- Economic and health benefits from conservation : Strategies that aim to conserve and protect local environments can improve factors like agricultural productivity, and subsequently boost local economy and increase stability, promote health through the conservation of local fauna and flora and elements of the natural systems, as well as elements of human permanence

3. The Team

- As mentioned previously, regarding the multidisciplinary nature of the work, it will require a relatively broad cast of local fauna, flora and natural components experts for each category of the studied elements, it will also include biologists and climate experts as consultants.



An example fo the fieleds that the experts will need to be proficient in five distinct categories in the case of our model : History and administrative (representing social values), Flora, Fauna, Water resources and Geology.

Elements that will need to be taken into consideration are within the field of the following experts : Histor and Anthropology experts, Real-estate experts, Biology experts, experts in the fields of local flora, climate experts, experts in the field of fauna, water resource experts, natural disaster risk assessment experts, and Geology experts.

- The framework itself being digital, Experts in software engineering will be required to assist with the process of translating the logic of the intervention and the control factors into an interactable and customizable interface.
- The supervisor will have the role of coordinating the multidisciplinary team as well as the computer/software engineers to allow for a coherent workflow.

4. Project Objectives :

- This initiative's objective is to create what will become the first global Algerian oasis ecosystem preservation tool, specifically tailored for Oases in Algeria.
- The project also aims to create employment seen as there will be a necessity for a coordinated mutlidisciplinary team as consultants, as well as a technical team for maintenance.

- The global estimation for job creation so far is about 50 jobs per oasis, in a country where oasis presence is in the 2000s, this allows for a perspective of over 100000 jobs across the country.

5. ***Project Implementation :***

- Study and Estimations
- Requesting Equipment
- Hiring of Experts
- Accelerated formation and initiation to methodology and process
- Formulation of analogue framework
- Interpretation of analogue framework through digital interface
- Creation of protoype

			Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7
1		Study and Estimations	X						
2		Requesting Equipment		X					
3		Hiring of Experts			X				
4		Accelerated formation and initiation to methodology and process				X			
5		Formulation of analogue framework					X		
6		Interpretation of analogue framework through digital interface						X	
7		Creation of protoype							X

<table>
<tr>
<td rowspan="2">Key partners :
• Environmental experts
• Experts of different fields of nature : geology, vegetation, wildlife.
• Local experts of oasis ecosystem</td>
<td>Key activities :
• Data collection and updating
• Data interpretation
• System integration
Interface management
• counseling</td>
<td rowspan="2">Offer :
• New mode of operation for data analysis.
• Oasis data layout
• Oasis data evaluation
• Counseling and proposed site usage based on compatibility
• Accurate results based on verified environmental data</td>
<td>Customer relationship :
• Consistent updates to optimize interface and fix potential issues
• Constant maintenance, data management and updates
• Upgrades to interface and user experience
• Availability of Customer service</td>
<td rowspan="2">Clients :
• Local authorities
• Local Oasis land owners
• Local farmers</td>
</tr>
<tr>
<td>Key resources :
• Multidisciplinary experts : environmental consultants, climate consultants, fauna and flora, wildlife and forestry experts
• Computers (capable of simulation and calculations)
• High resolution monitors
• Printers and tracers
• Vehicles for data collection</td>
<td>Chanels :
• Targeted calls to authorities
• Meetings with authorities to present project
• Presentations</td>
</tr>
<tr>
<td colspan="3">Costs :
• Interdisciplinary formations
• Experts remuneration
• Software engineers
• Potential data and map acquisition</td>
<td colspan="2">Revenues :
• Initial Payment for access.
• Subscription-based payment for extra functions, expert consultation and online services.</td>
</tr>
</table>

II. <u>Second Axis : Innovative Aspects</u>

1. The Nature of innovations :

- The process and idea in itself is not a far fetched concept, it was first theorized and presented by Ian.Mcharg as a methodology for establishing value systems that encompass natural an social parameters, but our innovation is in the transposition of such method in a new context which is the oasis and its ecosystem, as well as a second point for innovation which is the specificity in which our interface operates, as the mental map that constitutes our system is by itself what differentiates this intervention from others, every factor and parameter taken into account is unique to our environment and cannot be found with that level of similarity anywhere else.

2. *Areas of innovation :*

- Contextual : as previously mentioned, a version of the methodology has already been explored but not in the context of the saharan desert.
- Specialization : As the shift towars the specific context of algerian oases allows for the existence of a specialization in the methodology, making it innovative in that sense.

III. Third Axis : Strategic Market Analysis

1. *The market segment :*

- Potential market : Any administration or authority that has control or influence over environmental decision making and policies within oasis space in Algeria.
- Target Market : The specific target market are local authorities, initially Bousaada's local authorities as the application provides a clear pattern of action regarding the precious Ecosystem of the oasi,
- Reasons for target market choice : The software being developed serves as a global protection tool, so it is best left in the hands of authorities who do have a certain power in terms of decision-making, as they can ensure that any intervention they make at the scale of their cities or jurisdiction does not harm the oasis ecosystem, it also allows them to enforce laws and regulations that would cotribute directly to preserving the local oasis and it's ecosystem.

2. *The measure of competition intensity*

- Concurrence would be engineers and GIS experts but seeing their lack of presence in the first place, coupled with the need for a multidisciplinary team within the context of this very specific type of operation, adds to the potential success of our operation, as virtually they can provide alot less than what a qualified team can within our frame of operation.

IV. Fourth Axis : Production and Organisation Plan

1. *Process of production :*

- The process involves an initial model in the form of software which can be accessed through a subscription-based plan.

- The production of the model requires the involvement of a competent team of topic experts (oasis ecosystem) and the engineering team (software and computer sciences), on top of which a coordiator will be in charge of supervising the process of materialization of methodology from analogue to digital, which after testing and iterating will produce the first prototype.

2. ***Supply***
   - The software will be supplied online through it's own website, authorities will be able to download and access it online.
3. ***Workforce***
   - The principle Actors responsible for the maintenance of the software will be the software engineers, then the Oasis ecosystem experts who will act as consultants
4. ***Main partners***

V. Fifth Axis : Financial Plan

1. ***Costs and charges.***
   - Overall cost is estimated to be around 1,000,000 dinars (taking the equipment into accound : Computers, Tracers, Printers, Cars potentially for major displacements)
2. ***Turnover.***
   - Profit will be generated from the subscription fee attached to the product, as well as subsequential services like consultations.
3. ***expected results accounts***
4. ***treasurer's plan***

VI. Sixth Axis : Experimental Prototype

Experimental prototype:
PRODUCING THE MAPS:

The next step consists of producing the maps, which has been done through various means, including the use of ESRI satellite maps, and drawing maps on-site with the help of experts and local officials.

Historic Values:

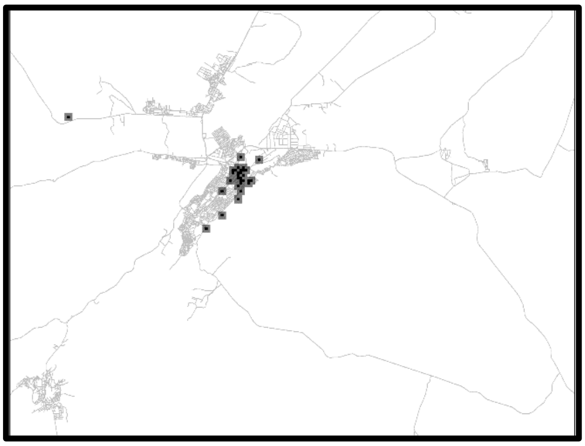


Figure 108: Historic Values. Source: Authors.

Scenic Values:

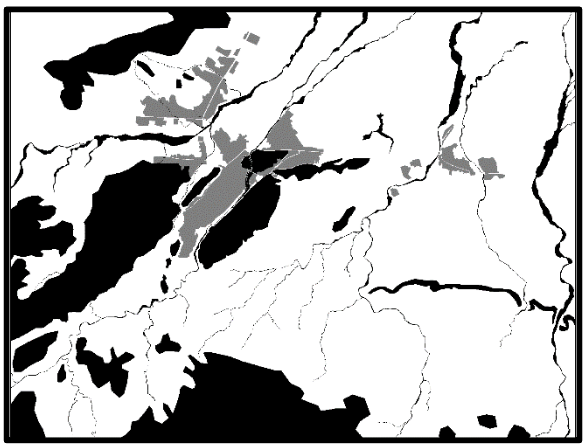


Figure 109; Scenic values. Source: Authors.

Prominent city landmarks and their close proximity were identified with the help of a local expert **(SAID HABICHE)**, as well as their estimated state (good condition, partially deraded, completely degraded).

Scenic features as well as urbanized areas with no prominent viewshed have been identified, the remaining areas represent open viewsheds with perspectives on the scenic features.

Administrative Values (social values):

Figure 110: Social values. source: Authors.

Administrative values have been identified according to existing land values with the help of the mayor of Bousaada to formulate a map with the highest potential land value in the future, as well as secondary and tertiary consideration for further land development.

Vegetal Coverage

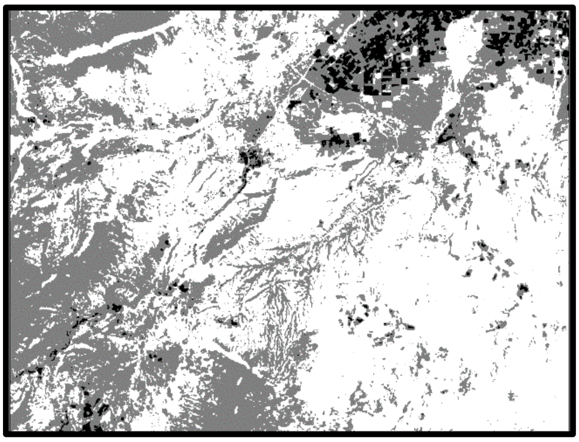


Figure 111: Vegetal density. source: Authors.

Because of the lack of data that specifies the condition of local fauna or flora, our next obvious indicator is represented by vegetal coverage density, as more dense vegetation also indicates better health for the existing flora

Ecological association Values:

Identifying individual species has proved being quite difficult, as inventories for local vegetal components exist but cartography (botanic maps for example) seem to be absent, older studies of the vegetal cover and composition of the area (Chott el Hodna) are present and available but deemed to be too old be able to be used in our study, in addition to the fact that they would still need interpretation by experts to classify the degree of importance of the species.

Farmland (Vegetal Type):

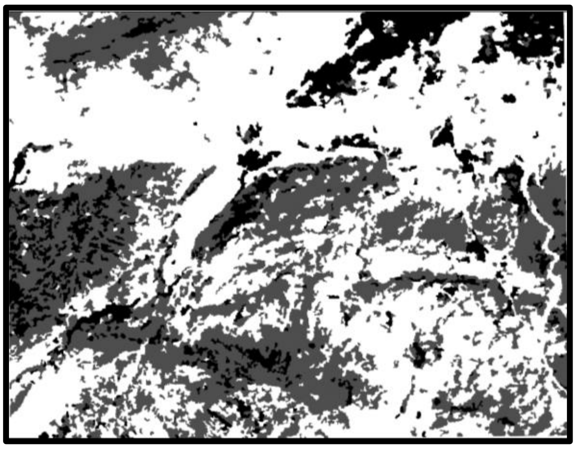


Figure 113: Vegetal type. Source: Authors.

Satellite data (African living atlas) has been able to provide us with an accurate categorization of vegetal typology, the most important being agricultural, followed by grassland and other lower density vegetation which are considered valuable for grazing, and lastly barren land and minimal

Tidal Inundation (Proximity to streams):

Figure 112. Tidal inunation. Source: Authors

Tidal inundation has been estimated to start from the streams themselves covering a relative proximity for immediate flood, the next area seems to be the most compatible with urbanization as it decreases the distance from the closest water source and it follows the same pattern as Bousaada's old city centr and it's relative distance from the stream. The furthest distance ist he least considered due to its distance from any potential water source.

STREAM TYPOLOGY:

Figure 115: Stream typology. Source: Authors.

As an alternative map to surface water typology, seen as the only prominent surface water features within bousaada are streams, has been produced manually with combination of satellite imagery as reference for confirmation. (DEM, OSM, and GOOGLE EARTH imagery).

AQUIFERS:

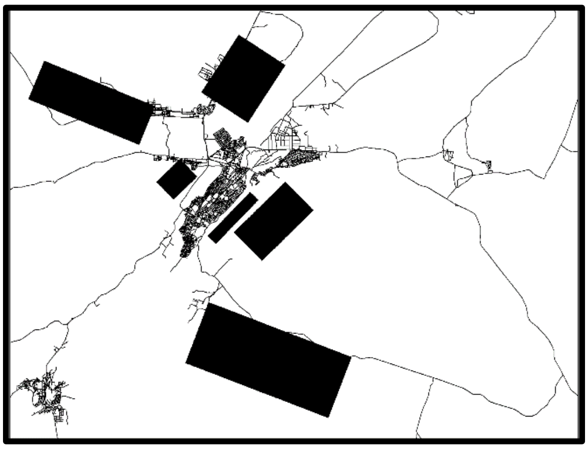


Figure 114: Aquifers. Source: Authors

The highest Potential for aquifer presence has been identified based on an existing hydrogeological study of the area.

WILDLIFE VALUES:

Wildlife location maps have proven to be difficult to establish despite the existence of an extensive inventory of local species within Bousaada, interviews with Experts as well as documents provided from research projects and thesis' have confirmed the existence of over 48 different recorded species in the avian category alone. In addition to various other endemic species that have also been confirmed to exist within Bousaadaa (Mammals, Reptiles, Insects and even fish within the region of El'Hodna), but the absence of concrete maps (or the conditions for the existence of environments for said species) that depict locations of natural habitats as well as feeing/breeding grounds has unfortunately led to the inability to produce the map, but opens up potential for future establishment of such maps.

SURFICIAL GEOLOGY:

In terms of identification of the most suitable land for laying suprficial foundations, surficial geology maps could not be elaborated due to the lack of information, despite the availability of geologic studies and pedology maps, factors like potential erroneous information (old pedology maps which have been modified/corrected) and the unavailability of means to transcribe geologic informations (availability of information but inability to interpret it within our context), has led to the absence of this map within our study context (1968).

EROSION:

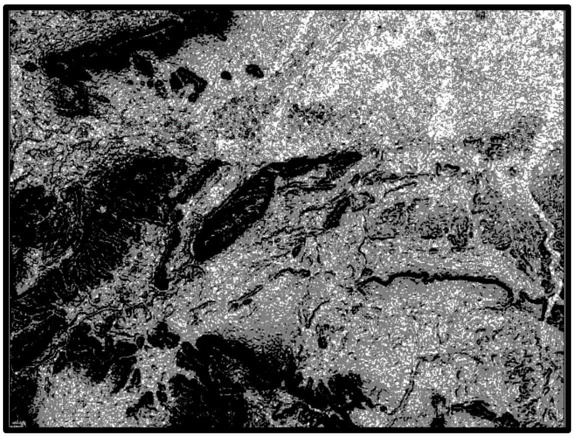


Figure 117: Erosion. Source: Authors.

Producing erosion maps requires taking into consideration both slope percentage and the nature of soil. As previously mentioned due to the unavailability of geological data, and thus the nature of soil, only slope percentage has been taken into account for considering areas of potential erosion.

SURFACE DRAINAGE:

Figure 116: Surface Drainage. Source: Authors.

Have been produced by using Streams maps, representing drainage chanels.

GEOLOGIC FEATURES:

No significant geologic feature seems to be prominent other than Djbel Kerdada, which alongside the absence of concrete data that can highlight geologic features worthy of scientific or historic interest, leads to a broader approach which is represented by the physiographic features maps.

Slopes:

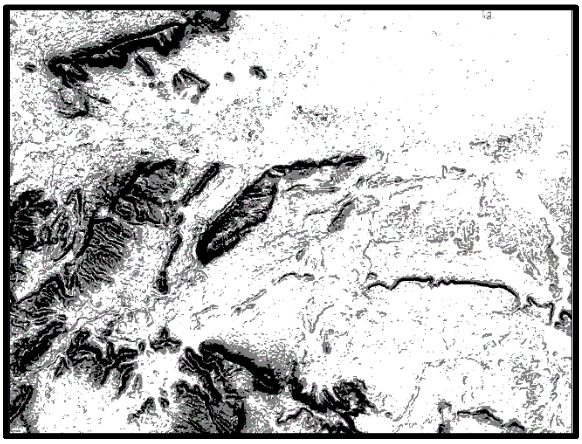


Figure 119: Slopes. Source: Authors.

Slope maps have been synthesized using satellite data (DEM).

Physiographic Features:

Figure 118: Physiographic features. Source: Authors.

Physiographic Features have been identified and manually delineated through the use of satellite data (extracted from DEM)

Urbanized Areas:

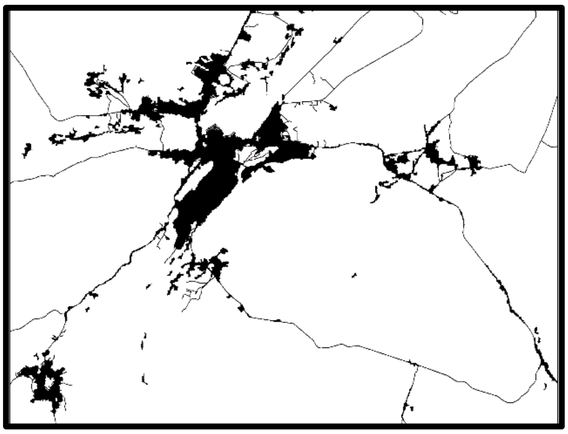


Figure 121: Urbanized Areas. Source: Authors.

Urbanized Areas map resulting from a manual synthesis of satellite imagery (African Living Atlas, GOOGLE EARTH)

Proximity to roads

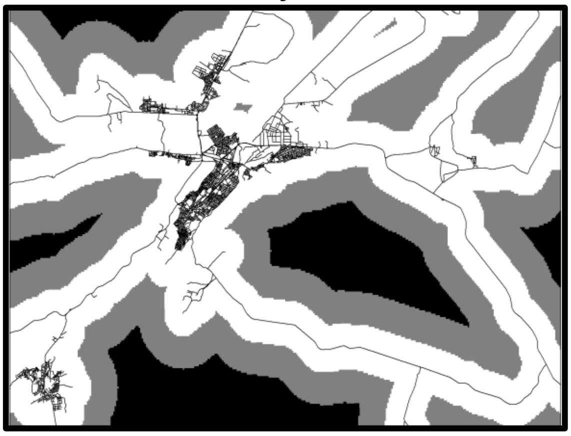


Figure 120: Proximity to roads. Source: Authors.

Proximity to roads was based off existing

Map value categorization for Urbanization compatibility:

In order to establish suitability for urbanization, each map feature has been categorized within 3 values, from lowest to highest in terms of compatibility with urbanization, which allows us to identify areas with the highest tolerance for

	Stream Type (1)	**Tidal Inundation (Stream Proximity) (2)**	**Vegetal coverage (type) (3)**	**Slope (4)**	**Vegetal Coverage (Density) (5)**
Least Urbanizable	Primary and Secondary	Flood-prone zones	Agricultural Land	Above 25%	Highest Density
Conditionally Urbanizable	/	Furthest zones from streams	Grassland and Medium density vegetation	25-10%	Medium Density
Most Optimal for Urbanisation	Absence of Streams	Proximity to stream above flood line	Lowest density vegetation and barren lands	10% or less slope	Lowest Density

urbanization.

	Surface Drainage (6)	**Scenic Values (7)**	**Susceptibility to Erosion (8)**	**Physiographic Features (9)**	**Social Values (10)**
Least Urbanizable	Absence of Drainage Features	Scenic Features	10%+ slope	Presence of major Physiographic features	Urbanized Areas And low value areas
Conditionally Urbanizable	/	Urbanized Areas with litte/no viewsheds	2.5-10% slope	/	Secondary, tertiary and last considerations for expansion
Most Optimal for Urbanisation	Presence of Drainage Features (channels and streams)	Areas with prominent views on scenic features	2.5% or less slope	Absence of major Phyiographic features	Prime Value land

Map weighing:

Individual map weight has been taken into consideration as an additional factor for

	Historic Values (11)	**Road Proximity (12)**	**Aquifer (13)**	**Urbanized Areas (14)**
Least Urbanizable ■	Presence of significant Historic Landmarks	Furthest from roads	Presence of aquifers	Presence of Urbanized Land
Conditionally Urbanizable ■	Walkable Proximity to significant Historic Landmarks (50m)	Average distance from roads	/	/
Most Optimal for Urbanisation □	Absence of significant Historic Landmarks	Closest proximity to roads	Absence of Aquifers	Unurbanized areas

considering map influence over the final result (each map is represented by its respective ID) the chart is broken down into 3 categories as follows:

- A: Highest weight/influence. (9.2%)
- B: Medium/average weight/influence. (7%)
- C: lowest Weight/influence (2.5%)

The influence of each map is calculated so that the total always equals 100%,

The maps are categorized according to how influential they are, more tangible factors like slopes and natural barriers or physiographic features that count as direct restrictive factors are considered more impactful than metaphysical factors like land value estimations or scenic view sheds.

Weight Category	**Map ID**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
A				X	X					X			X	X	
B		X	X			X	X		X			X			X
C								X			X				

Map Synthesis:

The maps can then be synthesized into various composite maps, according to the categorization of their features:

Urbanizable:

Highest Suitability for Urbanization (Lowest social cost)

Lowest Suitability for Urbanization (Highest social value)

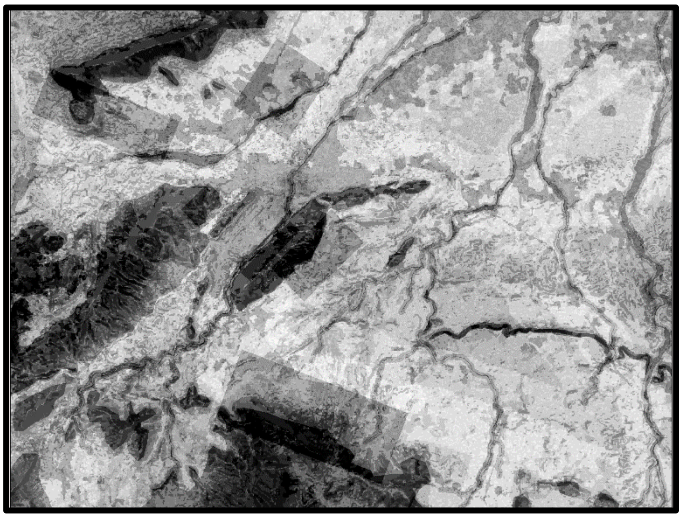


Figure 122: Unreclassified Urbanization suitability composite. Source: Authors.

Reclassified Urbanizable:

Reclassification increases map readability by separating Gradients into multiple categories :

- Optimal suitability
- Conditional suitability
- Unsuitable for urbanization
- Low suitability
- Unsuitable

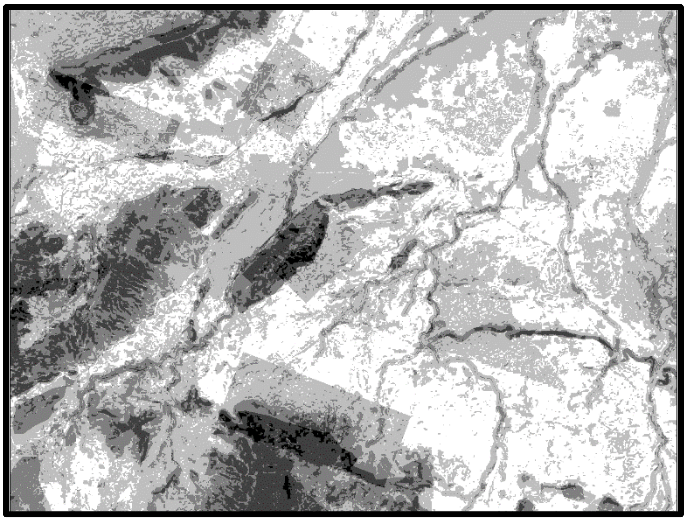


Figure 123: Reclassified Suitability for Urbanization. Source: Authors.

Residential:

Highest Suitability for Residential (Lowest social cost)

Lowest Suitability for Residential (Highest social value)

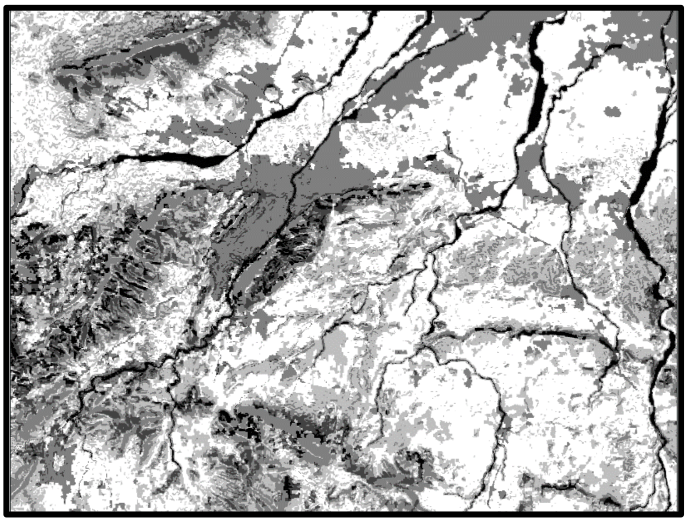


Figure 124: Composite: Residential suitability. Source: Authors.

Passive Recreation:

Highest Suitability for Passive Recreation (Lowest social cost)

Lowest Suitability for Passive Recreation (Highest social value)

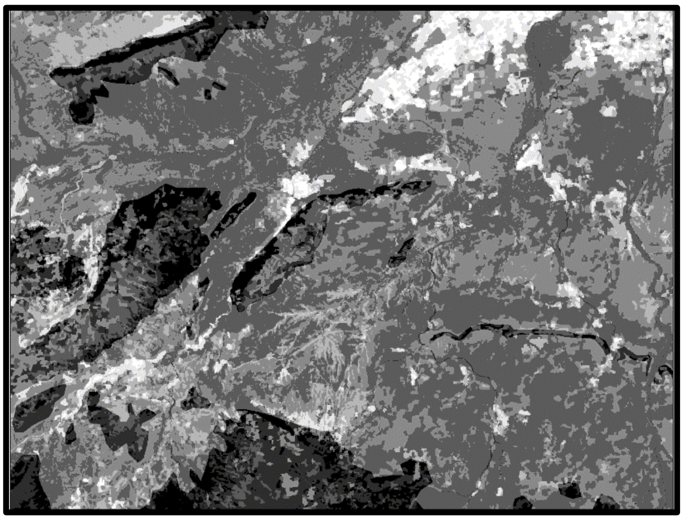


Figure 125: Composite : Passive recreation Suitability. Source : Authors.

Active Recreation:

Highest Suitability for Active Recreation (Lowest social cost)

Lowest Suitability for Active Recreation (Highest social value)

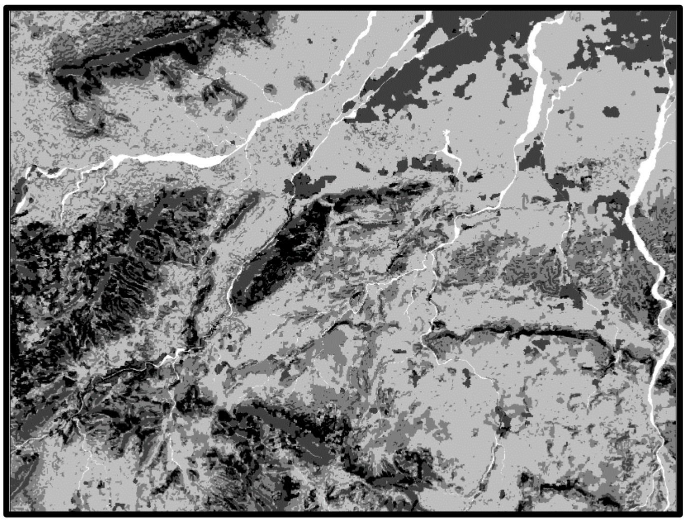


Figure 126: Composite: Active recreation suitability. Source: Authors.

Commercial Industrial:

Highest Suitability for Commrcial Industrial (Lowest social cost)

Lowest Suitability for Commercial Industrial (Highest social value)

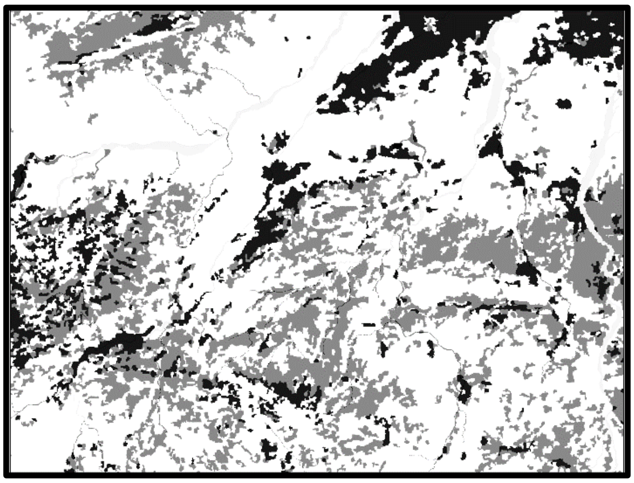
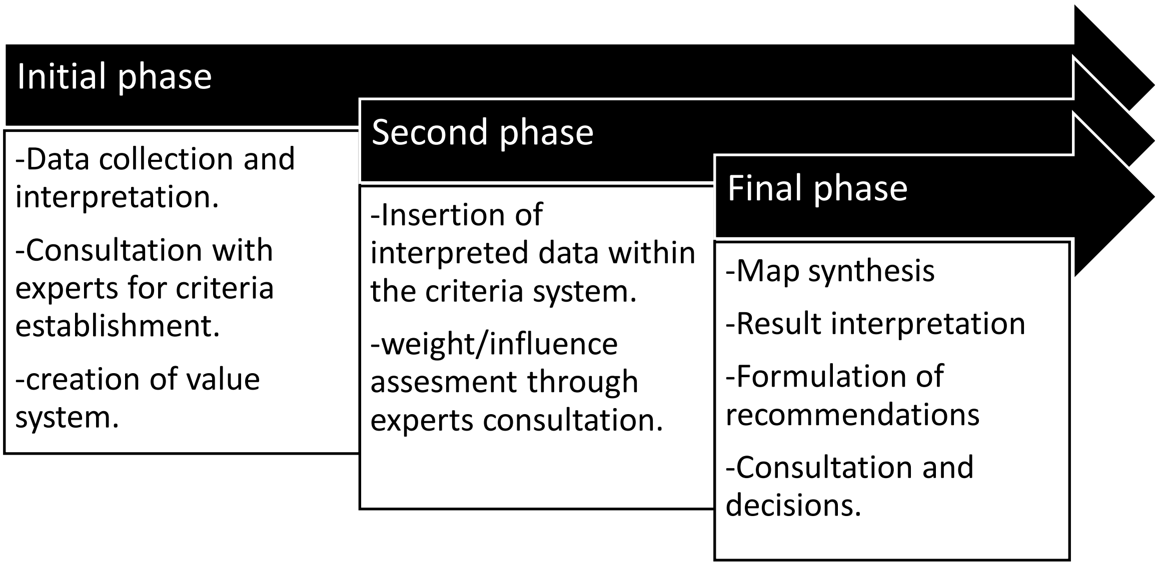


Figure 127: Composite: Commercial-Industrial Suitability. Source: Authors.



Conclusion:

The purpose of this analysis was to demonstrate the possibilities of identifying land compatibility based on a holistic method that gathers different categories and factors within those categories, which when followed by a criteria-based deconstruction of each component, and individual reassessment within an elaborated value system, presents us with a set of indicators for specific purposes that can be predefined.

The presented study of compatibility can help preserve the local natural environment and its components through the isolation of the highest value features (which are highlighted as being the least compatible with activities of urbanization) and in that sense ecosystem preservation is encouraged through the protection of its components.